TRANSIENT

T E C H N O L O G I E S

VIY®3
Ground Penetrating Radar

User Manual

Contents

General Information

VIY3 GPR Application

VIY3 Ground Penetrating Radar (GPR) is designed for non-destructive investigation of various media.

The GPR can be used by geophysicists, builders, environmental organizations to detect and monitor the condition of underground utilities, including plastic and asbestos cement pipes, underground places of flood water and petroleum, groundwater levels and water-resistant layers, for investigating of structures and boat-walls, etc.

Applications of VIY3 series GPR

VIY3-070, VIY3-070i, VIY3-070w VIY3-070iw

- Картирование приповерхностных геологических структур;
- Картирование уровня грунтовых вод;
- Определение толщины ледяного покрова;
- Определение мощности водного слоя и картирование донных отложений;
- Определение зон сезонного промерзания, вечной мерзлоты.

VIY3-125, VIY3-125i, VIY3-125w VIY3-125iw

- Mapping subsurface geological structures;
- Mapping of groundwater levels;
- Thickness determination of the ice cover;
- Determination of the power of the water layer and sediments mapping;
- Determination of areas of seasonal freezing and permafrost.

VIY3-300, VIY3-300i, VIY3-300w VIY3-300iw

- Search for local facilities (pipelines, cables);
- A survey of engineering structures (building foundations, basements, etc.);
- Search for buried waste and graves;
- Location of underground excavations, karst and suffusion failures;
- Determination of boundaries of petroleum contamination.

VIY3-500, VIY3-500i, VIY3-500w VIY3-500iw

- Search for local facilities (pipelines, cables);
- A survey of engineering structures (building foundations, basements, etc.);
- Search for buried waste and graves;
- Location of underground excavations, karst and suffusion failures;
- Archaeological research;
- Determination of boundaries of petroleum contamination.s.

VIY3-700, VIY3-700i, VIY3-700w VIY3-700iw

- Search for hidden breaches in the walls of terrestrial plants, mines, tunnels, towers and floors;
- Search for violations in the construction of roads, runways;
- Archaeological research;
- Search for voids, hiding places, foreign inclusions.

Completeness of Delivery

VIY3 series GPR come in several set of items. The package depends on the tasks which should be executed with the GPR.

VIY3-070 GPR

The package of VIY3-070 GPR includes:

- AB3-070t – 70 MHz frequency transmitter unit with built-in battery.
- AB3-070r – 70 MHz frequency receiver unit with digital output and built-in battery.
- Charger – Charger for the battery.
- D Cable 6 – Data cable, 6 meters length.
- TB-3 – Transport belt.
  - ✓ Notebook is not included in the package contents and has to be purchased separately

VIY3-125 GPR

The package of VIY3-125 GPR includes:

- AB3-125 –125 MHz frequency antenna unit with digital output and built-in battery.
- Charger – Charger for the battery.
- D Cable 3 – Data cable, 3 meters length.
- TB-3 – Transport belt.
- User Manual.
  - ✓ Notebook is not included in the package contents and has to be purchased separately.

VIY3-300 GPR

The package of VIY3-300 GPR includes:

- AB3-300 – 300 MHz frequency antenna unit with digital output and built-in battery.
- Charger – Charger for the battery.
- D Cable 3 – Data cable, 3 meters length.
- TB-3 – Transport belt.
- User Manual.
  - ✓ Notebook is not included in the package contents and has to be purchased separately

VIY3-500 GPR

The package of VIY3-500 GPR includes:

- AB3-500 – 500 MHz frequency antenna unit with digital output.
- Battery Box – External box for the battery.
- Charger – Charger for the battery.
- D Cable 3 – Data cable, 3 meters length.
- DP Cable 3 – Cable to connect AB3-700 with Battery Box, 3 meters length.
- TB-3 – Transport belt.
- User Manual.
  - ✓ Notebook is not included in the package contents and has to be purchased separately

VIY3-700 GPR

The package of VIY3-700i GPR includes:

- AB3-700 – 700 MHz frequency antenna unit.
- Battery Box – External box for the battery.
- Charger – Charger for the battery.
- D Cable 3 – Data cable, 3 meters length.
- DP Cable 3 – Cable to connect AB3-700i with Battery Box, 3 meters length.
- TB-3 – Transport belt.
- User Manual.
  - ✓ Notebook is not included in the package contents and has be purchased separately

Order information
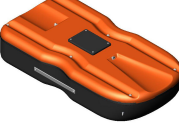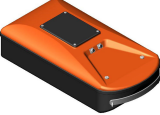
VIY3-500iw

Series title | Central frequency MHz | Built-in inclinometers | built-in WiFi channel

Additionally VIY3 series GPR can be supplied with equipment listed below.
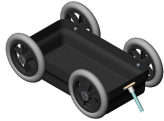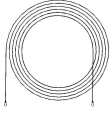
✓ Content of available equipment and accessories can be varied. Check completeness information with your dealer or manufacturer.

List of Equipment and Accessories

Title	View	Description
AB3-070t AB3-070r AB3-070ri AB3-125rw AB3-125riw		70 MHz frequency antennas units with digital output, built-in battery, GPS support and measuring wheel. Options Built-in inclinometers Built-in WiFi channel
AB3-125 AB3-125i AB3-125w AB3-125iw		125 MHz frequency antenna unit with digital output, built-in battery, GPS support and measuring wheel. Options Built-in inclinometers Built-in WiFi channel
AB3-300 AB3-300i AB3-300w AB3-300iw		300 MHz frequency antenna unit with digital output, built-in battery, GPS support and measuring wheel. Options Built-in inclinometers Built-in WiFi channel
AB3-500 AB3-500i AB3-500w AB3-500iw		700 MHz frequency antenna unit with digital output, GPS support and measuring wheel. Options Built-in inclinometers Built-in WiFi channel

AB3-700 AB3-700i AB3-700w AB3-700iw		700 MHz frequency antenna unit with digital output, GPS support and measuring wheel. Options Built-in inclinometers Built-in WiFi channel
Battery Box		Compartment for the battery, is in VIY3-500 and VIY3-700 packages
A-700		Adapter to connect VO-20 measuring wheel to AB3-500 or AB3-700 antenna unit.
VO-20		Measuring wheel to determine traveled distance, is compatible with AB3-125, AB3-300, AB3-500 and AB3-700 (required A-700).
D Cable 3		Cable (3 m length) to transfer data between AB3-125, AB-300, AB3-500, AB3-700 or Battery Box and notebook. Supplied with VIY3-125, VIY3-300, VIY3-500 and VIY3-700.
D Cable 6		Cable (3 m length) to transfer data between AB3-125, AB-300, AB3-500, AB3-700 or Battery Box and notebook.
DP Cable 3		Cable (3 m length) to transfer data between AB-500, AB3-700 and Battery Box. Supplied with VIY3-500 and VIY3-700.
DP Cable 1		Cable (1 m length) to transfer data between AB-500, AB3-700 and Battery Box when GPR is installed on Cart-36 or Cart-6.
Charger		Charger for lead acid batteries. Supplied with VIY3-125, VIY3-300, VIY3-500 and VIY3-700.
Cart-36		Handcart for sounding with VIY3-300, VIY3-500 and VIY3-700.

Cart-6		Vehicle cart for sounding with VIY3-300, VIY3-500 and VIY3-700.
TB-3		Transport belt to move the antenna unit by operator during the sounding without carts. Supplied with VIY3-125, VIY3-300, VIY3-500 and VIY3-700.
Synchro3		Software package to control VIY3 series GPR. As well as for processing and visualization of acquired data.

Components Description

GPR consists of antenna unit connected to computer (notebook) via USB. Operator controls antenna unit by the Synchro3 program. It adjusts antenna unit, checks state of its battery, makes sounding. Acquired data are stored in computer memory and can be displayed on the screen as GPR profile. Data processing is also executed by Synchro3 program.

AB3-070 Antennas Units

VIY3-070 Ground penetrating radar consist of two cases - Transmitter unt and Receiver unit. There are DATA, ADD and SYNCHRO sockets located on cover of the Receiver unit, SYNCHRO and CHARGE located on cover of the Transmitter unit. Every unit has the battery covers are fixed by four screws. To replace the battery is enough to remove the cover. For convenient carrying with two operators are carrying handles on the side of antennas units . Screws with rings for attaching belts between units and a transport belt are located in front and back of the antennas units.

Transmitter Unit

Carrying handle

Battery cover

Carrying handle

Receive Unit
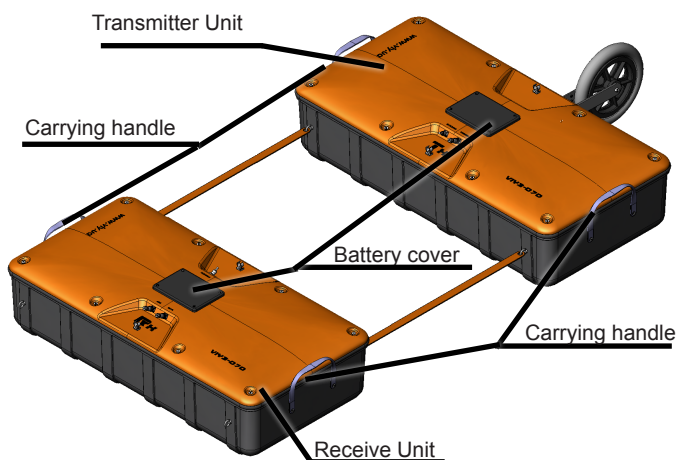
AB3-125 Antenna Units

Components arrangement of AB3-125 and AB3-125i antenna units are shown here. There are DATA and ADD sockets located on cover of the antenna unit. The battery cover is fixed by four screws. To replace the battery is enough to remove the cover. Belt carrying handles are on the side of the antenna unit for convenient carrying as one or two operators. Screws with rings for attaching a transport belt are located in front of the antenna unit.

ADD socket

Battery cover

DATA socket

Carrying handle

Rings for transport belt attachment
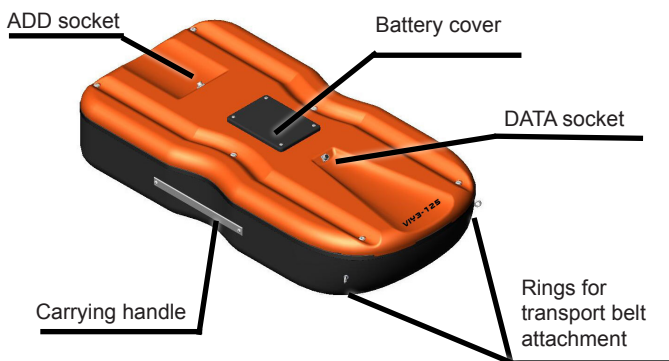
AB3-300 Antenna Units

Components arrangement of AB3-300 and AB3-300i antenna units are shown here. There are DATA and ADD sockets located on cover of the antenna unit. The battery cover is fixed by four screws. To replace the battery is enough to remove the cover. The grip belt for carrying the antenna unit is fixed with screws with rings for attaching the transport belt.

Battery cover

DATA socket

ADD socket

Carrying handle

Rings for transport belt attachment
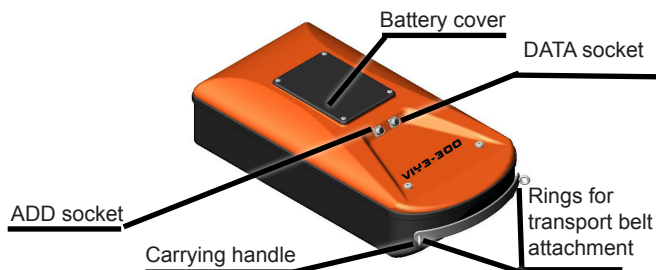
AB3-500

Components arrangement of AB3-500 antenna unit are shown here. To facilitate the antenna unit, battery is placed in a separate box. There are DATA and EXT sockets located on cover of the battery box. There are ADD and EXT sockets located on the AB3-500 antenna units. Antenna unit and battery box are connected by DP Cable via EXT sockets. Carrying handle is mounted on top of the antenna unit. The front screws of handle have rings to attach the transport belt during surface sounding.

ADD socket

EXT socket

EXT socket

Carrying handle

Rings for transport belt attachment

DATA socket
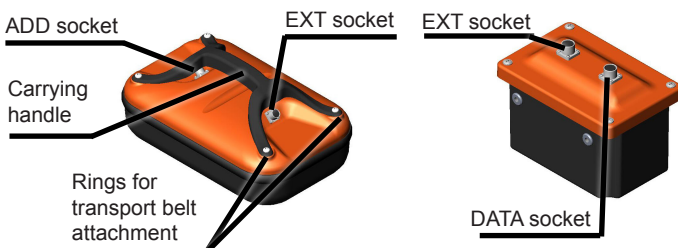
AB3-700 Antenna Units

Components arrangement of AB3-700 antenna unit are shown here. To facilitate the antenna unit, battery is placed in a separate box. There are DATA and EXT sockets located on cover of the battery box. There are ADD and EXT sockets located on the AB3-700 antenna units. Antenna unit and battery box are connected by DP Cable via EXT sockets. Carrying handle is mounted on top of the antenna unit. The front screws of handle have rings to attach the transport belt during surface sounding.

ADD socket

EXT socket

EXT socket

Carrying handle

Rings for transport belt attachment

DATA socket
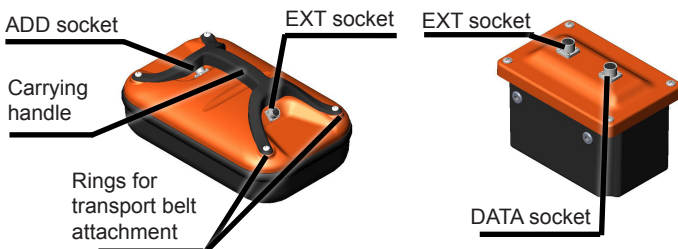
VO-20 Measuring Wheel

All antenna units are adapted for use with VO-20 measuring wheel. It is fixed to the antenna unit with two screws without using any tools.

Measuring wheel is connected to AB3-700 or AB3-700i antenna unit via A-700 adapter. The adapter is also fixed with two screws without special tools.
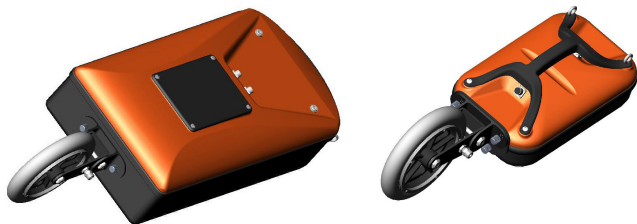
Cart-36 и Cart-6

AB3-300, AB3-300i, AB3-700 and AB3-700i are able to be mounted to both Cart-36 handcart and Cart-6 vehicle cart. To fix AB3-300 or AB3-300i antenna unit the same components, as for measuring wheel mounting are used. AB3-700 or AB3-700i antenna unit is arranged in the center of the cart. Battery box is fixed to rear wall of the cart. The cart has built-in measuring wheel that is connected to ADD socket of antenna unit. Example of mounting an antenna unit to cart is shown below.
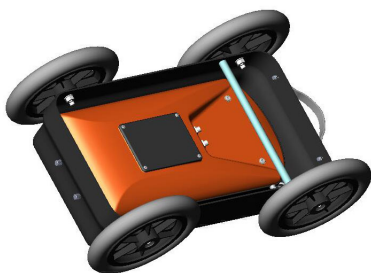
Software Description

Computer Requirements

The system requirements for the Synchro3 software are:

- Windows XP, Windows 7
- Pentium M with frequency more than 1500 MHz
- Memory at least 512 MB
- Port USB2.0
- At least 100MB free space on hard drive

Terms and Definitions

The User Manual uses the following terms and definitions.

Profile – a two-dimensional image in the coordinates of depth (vertical) and traveled distance (horizontal). Profile consists of a set of traces. Amplitude of the traces of the profile is displayed by color. The amplitude-color dependence is determined by color palette. For example, in the case of palette by default (grayscale), minimum value corresponds to black, maximum to white, and zero to gray colors.
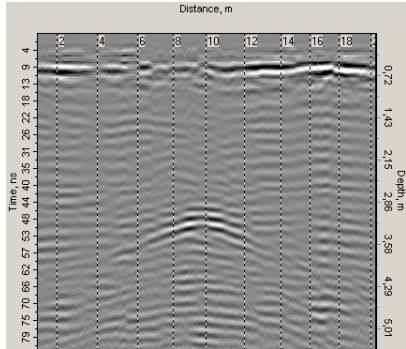
Trace – a set of samples that make up result of sounding in one point of profile. Profile is displayed by one-column pixels of different colors or curve (using **Wiggle** tool).

Sample – an elementary part of the trace is a single point on the profile.

Profile properties – there are configuration options of the GPR set before sounding (GPR model, trigger mode, number of samples per trace, etc.).

Tool – software module for profile processing in order to enhance the detection of subsurface heterogeneities and identify them.
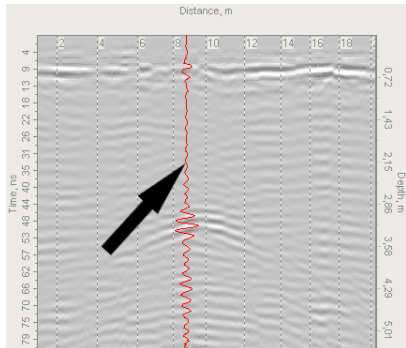
Main Window

Synchro3 software is developed to work with VIY3 series ground penetrating radars. It is a standard window application in Windows operating system. In initial state it contains the following items:

- Header;
- Main program menu;
- Working space;
- Status bar
- Information about the coordinates of the cursor.
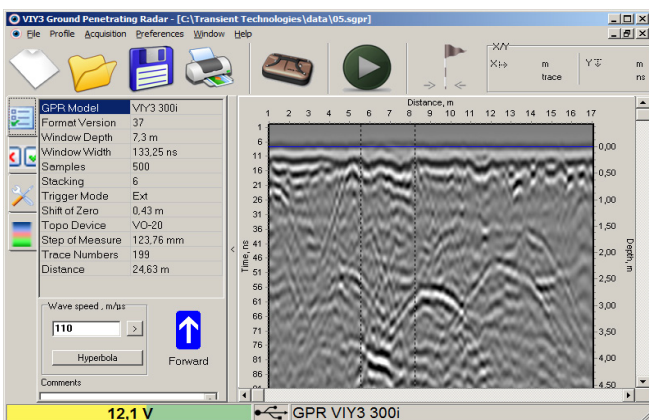
Header

Header is located at the top of the Synchro3 Main window. It consists of the application icon ⊙ and name. Click on the icon ⊙ or right-click on the header field. Standard Windows context menu with commands application window management appears.

Main Program Menu

The Main program menu is located below the header. It contains currently available items. Depending on the action (adjustment, sounding or profile processing), the set of Main program menu items is changed. If there are no open profiles, the Main program menu includes five items: **File**, **Acquisition**, **Preferences**, **Window** and **Help**. If at least one profile window is opened the **Profile** item is added to the Main program menu.

Each Main program menu item is set in correspondence a certain shortcuts. Press Alt. Note that in command of the Main program menu appeared underlined letters. They correspond to the shortcuts. To select any menu command, press Alt, and then the underlined letter corresponding to the called command.

Some of the more commonly used commands, assign hotkeys, which are listed to the right of the menu items. The left of the command located the corresponding icons. Icons of some commands are duplicated in toolbar under the Main program menu. For the convenience of field work buttons of increased size are available.

or

Status Bar

Status bar locates at the bottom of the Main Window. It displays model name of connected GPR, communication channel - USB or WiFi and battery charge condition.

12,1 V	⟵ GPR VIY3 300i
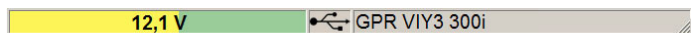
Cursor coordinates

X / Y. Display cursor coordinates on the profile. The horizontal coordinate **X** (distance from starting point) is presented in trace number and distance of the route (if odometer or GPS are presented). The vertical coordinate **Y** (depth) is presented in time and distance. Depth is calculated taking into account the initial bias of zero on the basis of wave speed in the medium specified in the **GPR Settings** window.

File Menu

File menu are intended for file manipulation of GPR profiles. It contains nine items.

Create, <Ctrl+N>. Create new profile.

Open, <Ctrl+O>. Open saved profile.

Open Recent. Quickly open the profile. Contains the last saved profiles (up to 16).

Close, <Ctrl+F4>. Close active profile.

Save, <Ctrl+S>. Save profile with the current file name.

Save As. Save profile with display dialog box that allows to specify file name and its location.

Export. Export profile to graphic formats (*.bmp, *.dat and others). The number of file formats is defined by export plug-ins presence.

Print, <Ctrl+P>. Print current profile.

Exit. Close Synchro3 program.
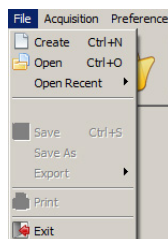
Profile Menu

Profile menu controls the profile display. It contains four items.

Top Axis. Set up the appearance of upper axis of the current profile. There are three options: **Distance**, **Traces** or **GPS data**.

Profile Offset. Setting of the profile displacement in relation to the measuring site (**By course**, **Aside**, **By height**). Necessary for the forming of C-scan.

Zoom In, <Gray+>. Change scale of the current profile to direction of increasing.

Zoom Out, <Gray->. Change scale of the current profile to direction of decreasing.
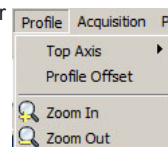
Acquisition Menu

Acquisition menu is to adjust profile parameters before sounding. It contains two items.

GPR Settings. Open dialog box for GPR settings. Such parameters as survey window, number of samples per trace, trace stacking, movement direction, wave speed, interval between the traces in the profile, trigger mode, and comments are presented here.

Start, <F2>. Start the data acquisition
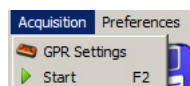
General Information

Preferences Menu

Preferences menu adjusts connected devices and the Main program window appearance. It contains three items.
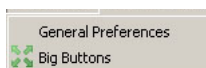
General Preferences. Access this dialog box with information about GPR as well as parameters settings of measuring wheel (odometer), GPS and inclinometers.

Big Buttons. Switching size of the buttons display Main program menu.

Language. Interface language: English, Russian, Chinese.

Window Menu

Window menu controls placement of profile windows in Main window. It contains five items.

Cascade. Cascade placement of all open profile windows.
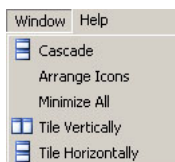
Arrange Icons. Placement of all minimized profile windows in the lower left corner of the Main window.

Minimize All. Minimize and placement of all minimized profile windows in the lower left corner of the Main window.

Tile Vertically. Placement of profile windows so, that they filled the whole field of Main window. Splits vertically.

Tile Horizontally. Placement of profile windows so, that they filled the whole field of Main window. Splits horizontally.

Help Menu

Help menu provides reference information about Synchro3 program. It contains two items.

Help. Reference information about Synchro3 program.

About. Displays information about Synchro3 program, including version number.

Profile Window

Each GPR profile is opened as a child window. Workspace of Profile Window is split into two areas. The right area displays the profile. The left area contains four tabs for working with the profile.
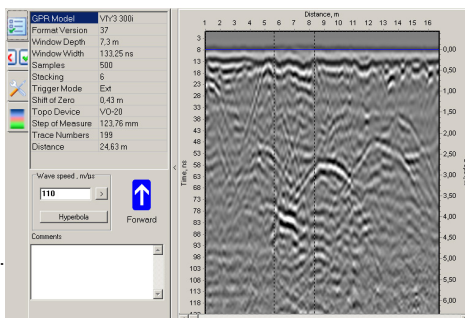
Profile Properties Tab

The tab displays settings of **GPR Settings** window. In the saved files are allowed to make changes without affecting the sounding process. There are medium, wave speed, comments and movement direction.

GPR Model	VIY3 300i
Format Version	37
Window Depth	7,3 m
Window Width	133,25 ns
Samples	500
Stacking	6
Trigger Mode	Ext
Shift of Zero	0,43 m
Topo Device	VO-20
Step of Measure	123,76 mm
Trace Numbers	199
Distance	24,63 m

Wave speed , m/μs

110 >

Hyperbola

Forward

Comments

View Tab

View tab provides capabilities to control and visualize the profile.

Zoom. Scale the profile from drop down list.

Scale options are the following:

Fit Width. Change the scale so that profile and window width are equal.

Fit Height. Change the scale so that profile and window height are equal.

12, 25, 50, 75. Scale proportionally reduction of current profile.

100. Restore initial scale of current profile.

200, 300, 400. Scale proportionally increase of current profile.

Zoom In. Scale smoothly increase of current profile.

Zoom
Q Zoom In
100
Q Zoom Out
Proportion X:Y
Samples 1:1 1:3 1:5
Distance 2:1 1:1 1:2
V Grid   H Grid
Markers
Show   Edit
Set Zero Level
Wiggle
Hand Tool
Flip horisontal
Topographic correction

Zoom Out. Scale smoothly reduction of current profile.

Proportion X:Y

Samples. Change ratio between vertical and horizontal scales when these scales calibrated in pixels.

1:1. Step of the vertical and horizontal scales are equal.
1:3. Step of the horizontal scale three times more than step of the vertical scale.
1:5. Step of the horizontal scale five times more than step of the vertical scale.

Distance. Change ratio between vertical and horizontal scales when these scales calibrated in units of distance.

2:1. Step of the horizontal scale two times less than step of the vertical scale.

1:1. Step of the vertical and horizontal scales are equal.

1:2. Step of the horizontal scale two times more than step of the vertical scale.

V Grid. Display vertical grid on the profile.

H Grid. Display horizontal grid on the profile.

Markers.

Show. Display markers on the profile.

Edit. Edit markers.

Set Zero Level. Set zero level of depth manually (automatically). Depth scale starts from zero level.

Wiggle. Display trace on the profile as A-scan. Trace selection corresponds to the cursor position on the profile.

Hand Tool. Navigate profile (scrolling) by Hand tool.

Flip Horizontal. Command reverses the profile horizontally, that is, from left to right.

Topographic correction. This function is available for profile obtained by antenna unit with built-in inclinometers and with measuring wheel. The topographic correction transforms the surface profile taking into account tilt of antenna unit during the data acquisition. See page 39 for details.

Tools Tab

Tools tab provides tools for profile post processing. Profile processing is performed by successive application of tools placing in the tools tree. The order of tools in the tree can be changed arbitrary. Number of similar tools in use is indefinitely. List of tools is stored in a separate file. Initial GPR profile remains unchanged. Multiply copies of the same profile can be processed by different sets of tools.

Tools

Add. Add a tool from the proposed list of tools.
Remove. Delete tool from the tools tree.
Properties. Edit settings of tool from the tools tree.
Execute All. Force execution of set of tools placed in the tools tree.

Set of Tools

Clear Set. Delete tools tree.
Save Set. Save tool tree as set of tools in separate file.
Select set of tool from drop down list of sets saved before.
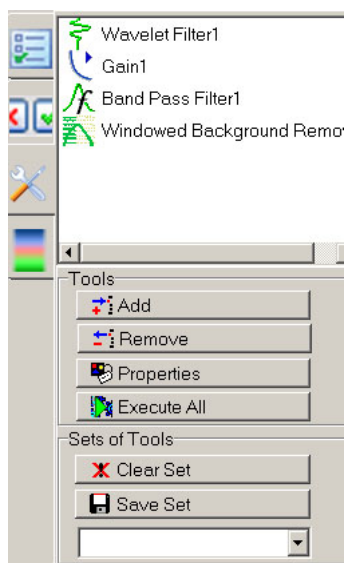
Palettes Tab

Palettes tab is to set-up the palette to display GPR profile.

Horizontal bar of current palette setting is located in the upper part of the tab. Below the green line shows the trace. Vertical bar of the right shows trace display using the current palette. The palette settings are saved in the GPR profile.

Save Palette button allows to save the current palette in the Palettes library. By pressing this button the current palette appears in the lower part of the tab as a button with the palette image.

Using the palette describe on page 40
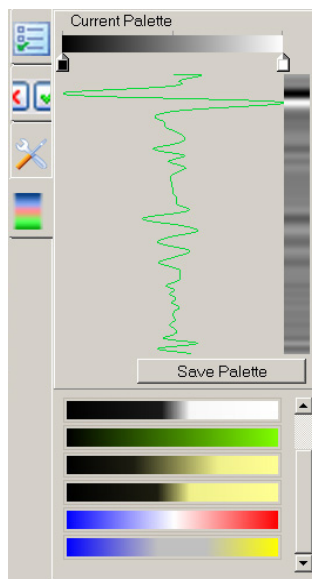
Getting Started

Software Installation

To setup Synchro3 software, do the following:

- Insert CD with Synchro3 software installation into CD player. Click **install.exe** from the root directory.
- Click the **Next** button of SmartGPR VIY3 Setup dialog box.

- Specify path to the program location in the next dialog box. The default path is C:\\Transient Technologies.
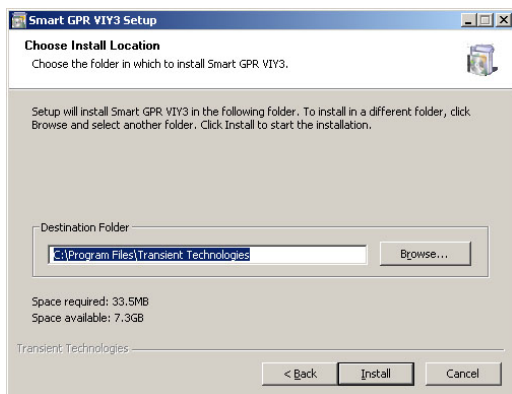
- Click **Install**.
- Click **Finish** in the next dialog box.

Driver Installation

Connect data cable (D Cable 3) to the DATA socket on the antenna unit, the second cable connector insert into the USB socket of your computer. Computer screen displays a message.
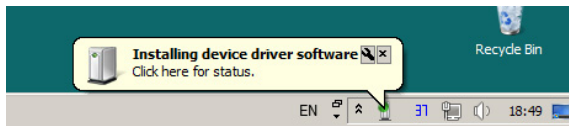
After a few seconds the following message appears.
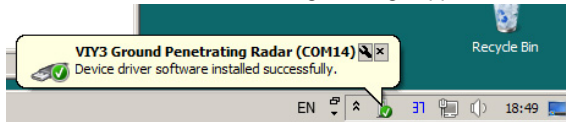
If you click on this message you will see the following window.
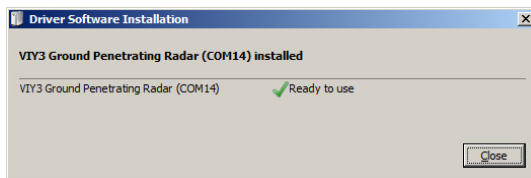
The driver has been successfully installed.

Site Preparation

Before the sounding, polygon should be cleared from large interfered objects. Data acquisition is carried out by straight movement of GPR on the surface.

one non rectilinear profile

two profiles
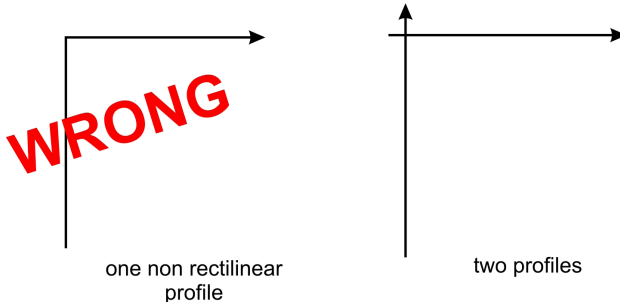
At the same time permanent GPR contact with the surface is desirable. If the data acquisition is performed without equipment for topographic location (GPS, measuring wheel) you have to pre-mark the site for manual tag topographic location installed by operator. GPR in this case should be moved along the surface evenly.

If you plan implementation of 3D survey, you have to pre-mark the site. The distance between adjacent profiles should no more than a half of required dimensions of the underground facility. The sounding is carried out preferably with measuring wheel. This will allow to use Slicer

software for horizontal cuts (C-scan).

½ size of target
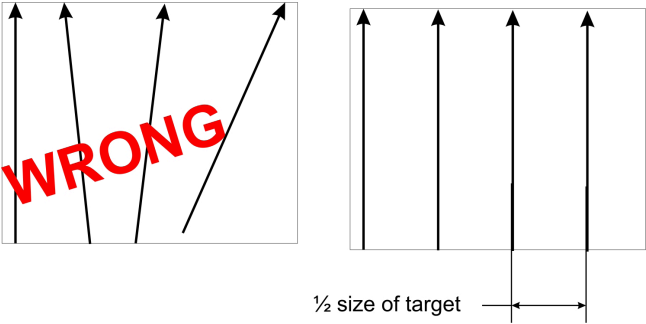
Parallel profiles are easier to perform with Zig-zag style. It is necessary to use **Direction** option.
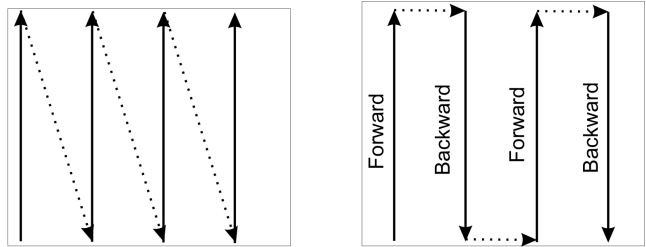
everywhere Direction=Forward

If the ground is rugged terrain, choose a point wise operation of GPR. In the case the device is placed at a point, make a single data acquisition, then move to the next point, sound again, and so on.

GPR Preparation

Connection of VIY3-70 Antennas Units

The following shows the procedure for connection of antenna units.

SYNCHRO   CHARGE

From Odometer
to Tx ADD

From Rx Synchro to Tx
Synchro

From Rx Synchro to
Tx Synchro

From Odometer
to Rx ADD

SYNCHRO

ADD

DATA

From Odometer
to Rx ADD

Rx Data to
laptop USB port
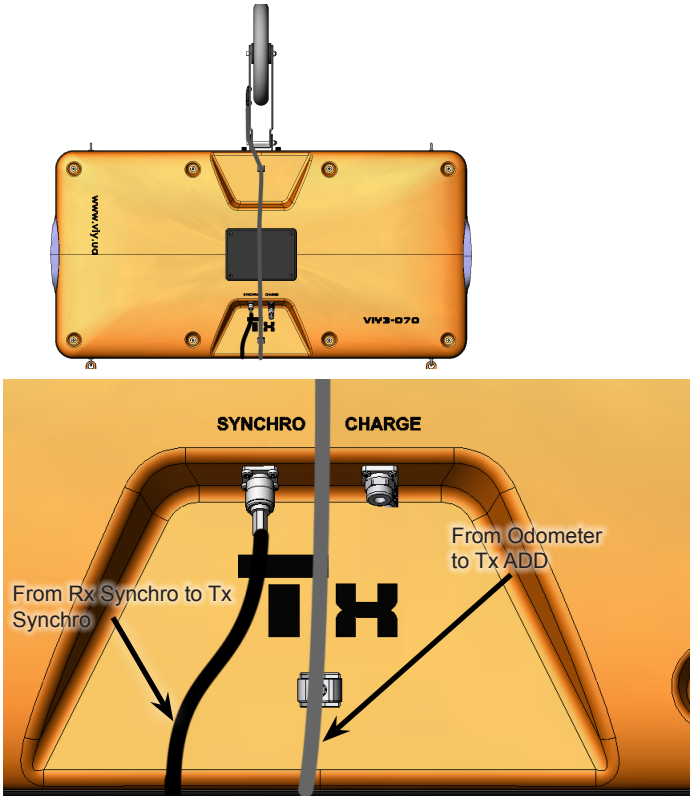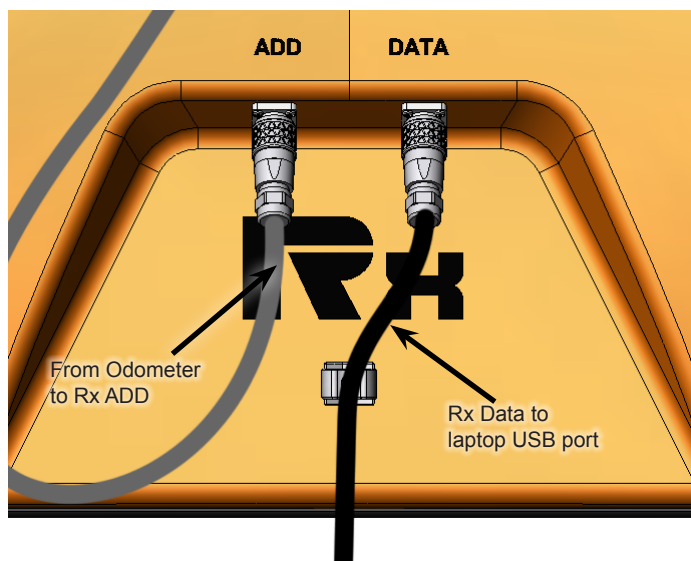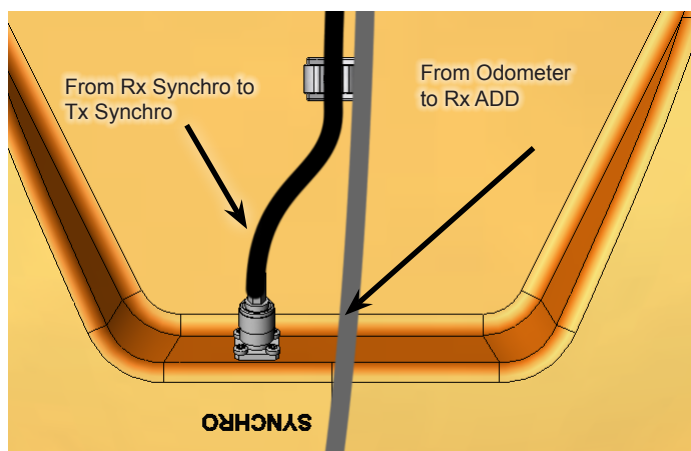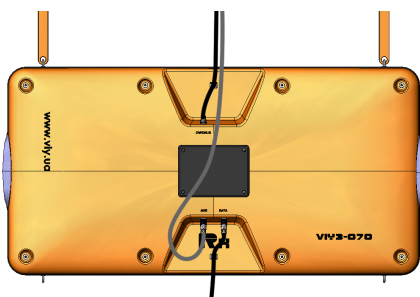
Connection of Antenna Unit to Laptop

Connect antenna unit to USB port on your computer with cable (D Cable 3). Insert the cable connector to **DATA** socket on a cover of antenna unit. At the same time the GPR power is switched on.

Connection of AB3-125 to USB connector of the laptop

Connection of AB3-300 to USB connector of the laptop

Connection of AB3-500 or AB3-700 to USB connector of the laptop

Connection VO-20 Measuring Wheel

Fasten measuring wheel to rear side of antenna unit by screws. Insert the cable connector to **ADD** socket on a cover of antenna unit.
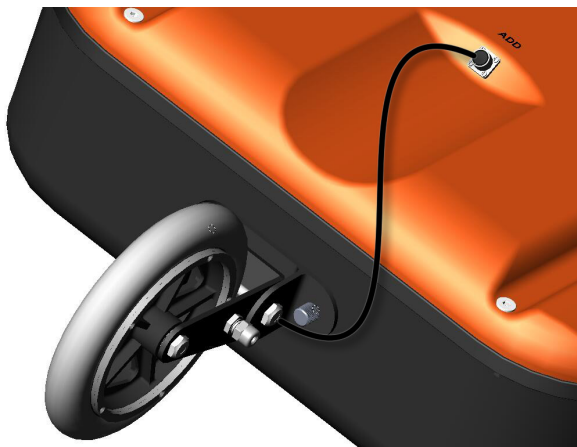
Connection of VO-20 measuring wheel to AB3-125 or AB3-125i (**ADD** socket)
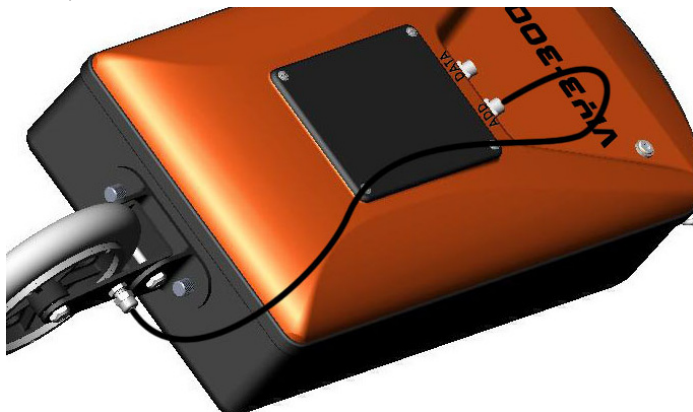
Connection of VO-20 measuring wheel to AB3-300 (**ADD** socket)

Connection of VO-20 measuring wheel to AB3-500 and AB3-700 (**ADD** socket)

If antenna unit is placed in Cart-36 handcart or Cart-6 vehicle cart insert cable connector of the cart's movement sensor to **ADD** socket.
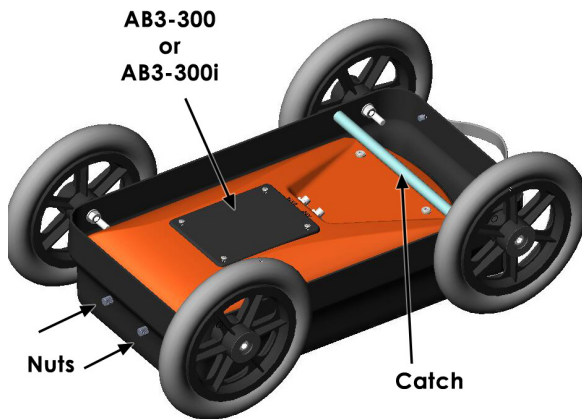
Placement of AB3-300 into Cart-36 and Cart-6
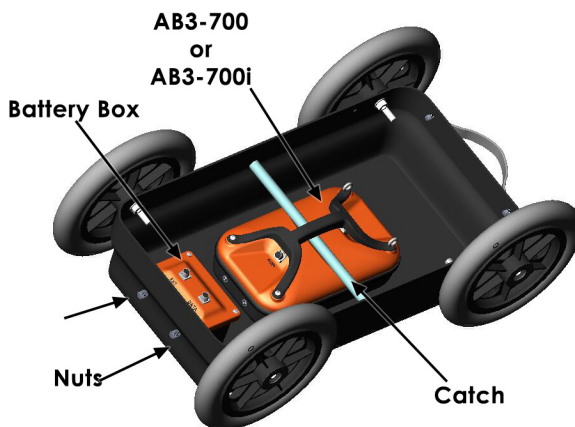
Placement of AB3-500 and AB3-700 into Cart-36 и Cart-6

Adjustment of Measuring Wheel

When using measuring wheel step of wheel should be specified. Select **Preferences > General Preferences** in Main menu. Click the **Wheel** option in the **Topo Device** area. Specify **Step of wheel**. Label with step value is on the measuring wheel.

Connecting of External GPS (NMEI device)

To connect external NMEI device, GPS, for example, it is necessary to use PTRS pigtail. The pigtail is not included in GPR package and should be ordered separately. Any external device with NMEI output protocol and RS-232 interface can be connected to antenna unit.

Getting Started

Use of Built-in Inclinometers

Some antenna units have built-in inclinometers. There are AB3-125i (VIY3-125i GPR package), AB3-300i (VIY3-300i GPR package) и AB3-700i (VIY3-700i GPR package). Built-in sensors measure tilt and roll of antenna unit. Information about antenna tilt and traveled dictance allow to do topographic correction. More about topographic correction read on page 39.

Inclinometers Calibration

Before starting the sounding make sure that inclinometers are calibrated. Place antenna unit on the ground and wait for 10 minutes in order to temperatures of the antenna unit and ambient are equalized. Connect the antenna unit to laptop and run Synchro3 software. Select **Preferences > GeneralPreferences**. Push **Test** button. Values of **Quality of calibration** and **Tilt** will change with orientation of the antenna unit. Value of **Quality of calibration** must be within 1,02...0,98 with motionless antenna unit. If **Quality of calibration** value exceeds this range it is necessary to calibrate the inclinometers.

Take the antenna unit to hands and push **Calibrate** button. Calibration coefficients (Xmin, Xmax, Ymin etc.) will vary. Slowly, without any sudden movements, rotate the antenna unit around longitudinal and then transverse axis. The antenna unit has to do complete turnover. Then push **Calibrate** button once again to finish the calibration.
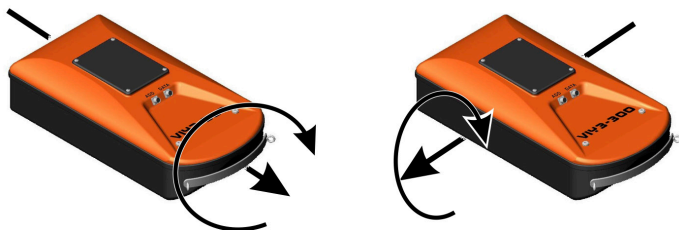
Make sure that **Quality of calibration** value is within acceptable limits. Otherwise, repeat the calibration.

Then follow the second and third stages of the tilt sensor calibration. Select a flat, solid surface of sufficient size with any angle to the horizon. Place the antenna unit on the surface in one direction, then click **Step2**. In a few seconds the button is switched off.
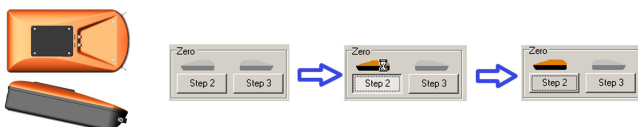
Turn the antenna unit to opposite direction, then click **Step3**. In a few seconds the button is swithced off.
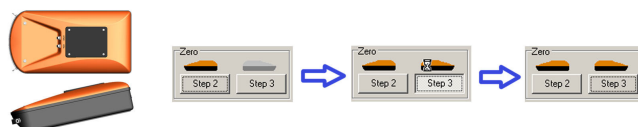
The calibration is finished.

Charge the Internal Battery

Antenna unit is equipped with sealed lead acid rechargeable battery (12 V, 7 Ah). Power supply of the antenna unit prevents deep discharge of the battery. Battery charge status is indicated in the Status bar of the Main window of the Synchro3 software. When the battery voltage approaches the critical value, the power supply begins to beep. If the voltage decreases below the cut-off threshold (10.8V) the power supply disconnects the antenna unit but it is continuing to beep twice per second. It indicates about serviceability of the GPR and the need to charge the battery.

To charge the internal battery use charger included in the GPR package. Put the charger connector to DATA socket of antenna unit and then plug the charger to AC power (220-240 VAC, 50-60 Hz).

To get more information see the charger's instruction.

To replace the battery unscrew four crews of the battery cover, make a change, fasten the cover again.

✓ Follow polarity of the battery (red wire connect to positive terminal, black wire connect to negative terminal).

Connecting GPR through WiFi

The versions of antenna units that have letter "W" in the name of a GPR, they will have a built-in WiFi. VIY GPRs provide the connection to a computer by using two different methods, which are direct connection and the connection through WiFi router.

To use a GPR with WiFi one needs connect the GPR to a computer with a USB cable. In the main menu of Synchro3 program go to Settings > General Settings. To manage WiFi connection, go to the WiFi frame.

First Connetion with GPR

Switch on the GPR by connecting a Data connector to the terminator that goes with the apparatus.

Press Start and go to Network and Sharing Centre. Afterwards, go to Change Adapter Settings in the popped-up window. Click the right button on the Wireless Network Connection. Choose Properties in the dropdown menu. Wireless Network Connection Status window will appear.

Double click on the Internet Protocol Version 4 (TCP/IPv4). Create a permanent IP address and a subnet mask in the Properties window.
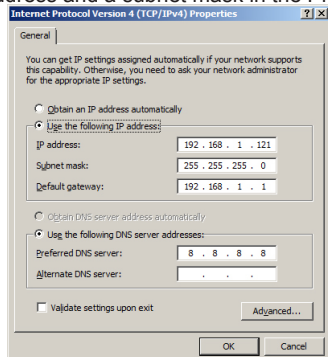
To manage the settings set the IP address that equals 192. 168. 0. 122 and the subnet mask that equals 255.255.255.0. Other settings do not matter. Click OK to save the settings. Shut down the Wireless Network Connection Status window.

Click on the icon 📶 in the right bottom corner of the screen with the right button of a computer mouse. See the list of wireless networks that are available.
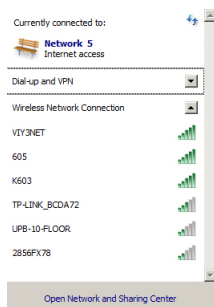
Find the VIY3NET network, click on it, mark the Connect Automatically parameter and press Connect..

Will begin the process of connecting to the network VIY3NET, after a few seconds a window will appear to enter the password.
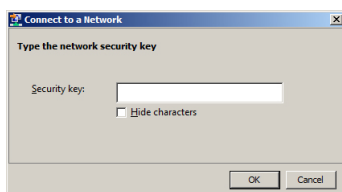
Enter the password which is VIY3PASS and press OK. In a few seconds VIY3NET will be connected.

Start Synchro3 program. It will connect the GPR automatically. Status bar will show the information of a built-in buttery voltage, GPR's type and

the WiFi icon .

If there is a need to use another network ID (SSID), password and other settings, one would need to disconnect GPR's terminator from the Data connector. Connect the GPR with a Data cable. In Synchro3 program go to Settings > General Settings. In the popped-up window make the necessary adjustments and press Save.

✓ IP address of the GPR and the IP address of the network card should be different and meet the subnet mask.

Connecting to a GPR using Wi-Fi router

GPR can be connected to the WiFi network by using a WiFi router. Such network topology allows us to increase the distance from the computer to GPR as long as router has an autonomous power supply. To configure the GPR connection using WiFi router, connect GPR to a computer using Data cable. In the main menu of Synchro3 go to Settings > General Settings. To manage WiFi connection, go to the WiFi frame. Left-click on the button
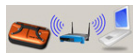
After that, adjust the network ID (SSID), network password, IP address and the subnet mask according to the router settings. Click Save.

✓ IP address of the GPR and the IP address of the network card should be different and meet the subnet mask.

✓ In a connection mode with router, GPR set the number of a WiFi channel automatically.

Disconnect data cable. Switch on a GPR by connecting terminator to the Data connector. The terminator goes with the apparatus. Start Synchro3 program. It will connect the GPR automatically. Status bar will show the information of a built-in battery voltage, GPR's type and the WiFi icon .

GPR Settings

Start the Synchro3.exe (**Start > All Programs > Transient Technologies > VIY > Synchro3**). The status bar at the bottom of the Main program window will appear. It indicates name of connected antenna unit and its battery condition.

Select **File > Create** in the Main program menu or press **Ctrl+N**. A new Profile window appears, and immediately GPR Settings window is opened.
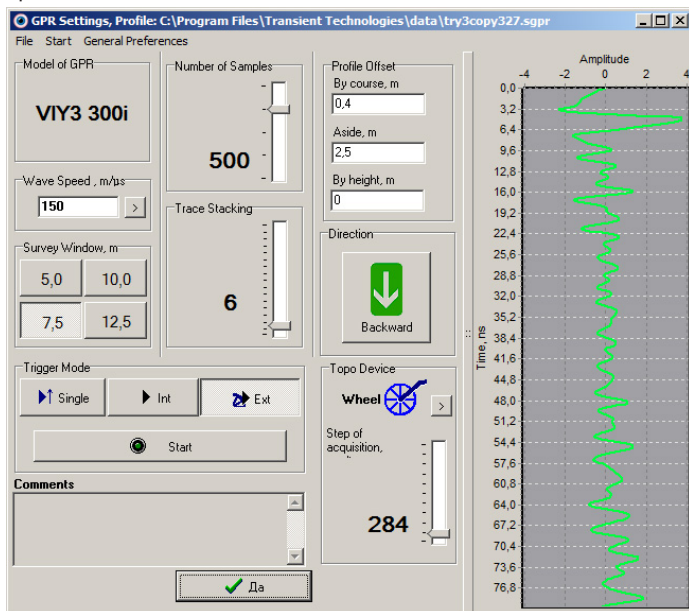
Then, do the following:

- Enter wave speed in medium in **Wave Speed** frame or click button and select required value.
- Select desired depth of sounding (**Survey Window** frame).

Select samples number per trace (**Number of Samples** frame). This option determines the level of vertical detail in obtained profile. **Recommended value is 500.**

- Select stacking value (**Trace Stacking** frame). This option affects the noise level in the profile. The higher stacking value, the greater noise reduction. **Recommended value is 10**.
- Specify type of external triggering device: **Not used**, **GPS**, **VO-20**, **Cart-36**. Adjust **Step of acquisition** if **VO-20** or **Cart-36** was selected. Adjust **Decimation of GPS signal** if **GPS** was selected. (**Topo Device** frame).
- Specify data acquisition mode: **Single, Int** or **Ext** (**Trigger Mode** frame), see page 33.
- Add comments: description of place and sounding conditions (**Comments** frame).
- To verify GPR operation, press **Start** button or select **Start** in the menu of GPR Setting window. The graph on the right side appears the signal received from the antenna unit. Make changes to the settings, if necessary. Close **GPR Settings** window.

Preparation of the GPR to work is completed.

Click **OK** button or close the GPR Settings window. Until beginning the data acquisition the GPR setting can be modified. **Select Acquisition > GPR Settings** in the Main program menu or click icon 🖱 in the toolbar.

The next profile settings corresponds to the previous one. You can

proceed the data acquisition immediately.

To save the GPR settings select **File > Save Settings** in the menu of the GPR Settings window. To use previously saved settings select **File > Open Settings** in the menu of the GPR Settings window.

Data Acquisition

After closing the GPR Settings window click 🔵 button in the tool bar or select **Acquisition > Start** in the Main program menu.

How to Move the Antenna Unit

Data acquisition can be carried out in three modes: single-run, self-starting and triggering by external device.

For the single-run mode (**Single**) mark the site previously. Then the antenna unit is installed on all points of sounding alternately, in which the single trace is acquired. To start the data acquisition press **Start** button of the Main program window or **F2** on your computer.

For the self-starting mode (**Int**) data acquisition is proceeded as quickly as possible. In this mode, the antenna unit should move evenly over the surface of the site. To start or stop the data acquisition press **Start** / **Stop** button of the Main program window or F2 on your computer. You can add marker tags during the sounding process. To add a tag press Space button on your computer.

For the third mode (**Ext**) data acquisition are triggered by external device of topographic location (measuring wheel, GPS, or any device transmitting data through the COM port in NMEI similar format.) Therefore, connect and configure an external device of topographic location before the data acquisition. If you apply measuring wheel enter the **Step of wheel**. Configuration of external devices is executed in **General Preferences** window.

To start or stop the data acquisition, press **Start** / **Stop** button of the Main program window or **F2** on your computer. Acquired data from GPR will only come after the measuring wheel rotation or availability of data from GPS. You can add marker tags during the sounding process. To add a tag press Space button on your computer.

Zero Distance Scale

Creating several parallel GPR profiles there is a need to set the mutual arrangement of profiles. For this reason there is a Displacement of profile in the window of settings. Displacement along the course (displacement of the beginning of profile in the in-plane profile regarding the system of coordinates) can be set in the Settings window previously measured the distance with a tape-line. However, there is more convenient way to set the displacement along the course. While moving the antenna and sounding the ground with a VO-20 measuring wheel or the GPR trolley Cart-36, one needs to press the button 🔲 on the toolbar or press Ins on the keyboard.

Speed of Movement of the Antenna Unit

In a single-run mode (**Single**) speed and way of the antenna unit movement are not important because the GPR waits for **Start** command after a single trace acquisition.

In the self-starting mode (**Int**) the data acquisition rate is determined by the GPR settings and are as fast as possible. It is important to move the antenna unit evenly and at the same speed in this mode.

The GPR settings determine the data acquisition rate. See the table.

Trace Stacking	Number of Samples				
	1000	500	333	250	200
1	29,77	59,21	88,33	116,76	146,63
2	16,77	33,50	49,90	66,43	82,70
3	11,69	23,25	34,71	46,20	57,59
4	8,97	17,85	26,68	35,42	44,18
5	7,26	14,52	21,62	28,78	35,90
10	3,73	7,45	11,15	14,84	18,45
15	2,52	5,02	7,5	9,94	12,44
20	1,89	3,81	5,68	7,51	9,38
25	1,52	3,02	4,56	5,99	7,53
30	1,27	2,56	3,83	5,02	6,25
35	1,09	2,17	3,26	4,33	5,37
40	0,95	1,89	2,83	3,78	4,72
45	0,83	1,68	2,51	3,37	4,20
50	0,76	1,51	2,32	3,03	3,78
55	0,69	1,37	2,07	2,77	3,44
60	0,64	1,29	1,90	2,51	3,16
64	0,61	1,18	1,80	2,36	2,94

The speed of the antenna unit movement is calculated as follow:

$v = d * f;$

where:

v – Speed of movement in meters per second,

d – Distance between the traces in meters,

f – Number of traces per second.

For example, if you need to get 10 cm distance between traces, and select **Number of Samples** as 500 and **Trace Stacking** as 5, the speed will be:

$v = 0,1 * 14,52 = 1,452 ≈ 1,5$ m/s

In the third mode (**Ext**) data acquisition is triggered by external device. If you select measuring wheel, sounding of the next trace is only started when signal from the wheel is received. **Step of wheel** is configured in the **GPR Settings** window. If you select GPS receiver, start of the next trace is when a message from the GPS receiver is received. GPS receiver is configured in the **GPR Settings** window.

✓ Do not exceed the permissible speed of the antenna unit. This will lead to a deterioration of GPR data.

If in **Ext** mode the antenna unit will move faster than permissible speed the notebook speaker will beep. It means that speed of movement must be reduced. The value of the maximum speed of the antenna unit depends on several settings of GPR:

Setting	Setting value increase results:
Number of Samples	reducing the speed limit
Trace Stacking	reducing the speed limit
Step of acquisition	increasing the speed limit

Maximum Speed of Data Acquisition

At the maximum speed of data acquisition (more than 60 traces per second), it can occur loss of acquired data with insufficient computer performance. In this case after stopping the sounding the following message appears: "Due to the lack of computer performance in the current profile of the data was lost. Change the setting of GPR and repeat the sounding".

Make sure that there are no any running programs consuming resources of your computer. If there is no any running programs except Synchro3, to prevent data loss change the GPR settings to reduce speed of data acquisition by increasing **Trace Stacking** and/or **Number of Samples**.

Save the Results

When you save the profile to the specified folder on your computer there are two files with the extensions *.sgpr and *.tls.

File with the *.sgpr extension contains all information about the GPR model, its settings, step of measuring wheel and so on. In the same file, unaltered, acquired data are stored.

File with the *.tls extension contains information about the list of tools applied to profile processing, their configuration and usage.

Such a way processed data are stored in two files with a common name but different extensions. No operator actions can permanently damage the data. To display the original profile enough to cancel (or delete) all used tools.

To save acquired data, do one of the following:

- Click **Save** button;
- Select **File > Save** in the Main program menu;
- Press **Ctrl+S**.

When you first save the document, **Save GPR Files** dialog box appears. Later, when saving document to be used selected path and file name.

Select **Save As** if you want to save the file with a different name.

Profile Display

Open Profile

To open acquired profile, do one of the following:

- Click 📂 button on toolbar pannel;
- Select **File > Open** from Main program menu;
- Press Ctrl+O.

The profile appears in Profile window.

Further processing is carried out by apply some tools to the profile. The result is displayed in real time.

Software from Transient Technologies supports compatibility with previous versions of the program and data storage formats. That is, the program older versions can work with data obtained from the program later versions and vice versa. Data storage is in the format of the current version.

It should be understood that the previous version of the program by opening the file later, do not read that part of the data or settings, which appeared in more recent versions. If you save the file by the program earlier version, this part of the data will be lost.

The latest version of the Synchro3 software is always available on the Transient Technologies' Web site: **www.viy.ua**.

Wave Speed Editing

Velocity of electromagnetic waves in the medium being sounded is not known beforehand. Therefore, before the data acquisition set the estimated speed or selected from a list (if one can determine the type of soil). Then, the processing profile, this parameter can be changed.
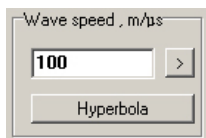
To edit wave speed select **Profile Properties** tab in the Profile window of the current profile. To change the wave speed do one of the following:

- Enter wave speed in the **Wave speed** frame;
- Click button [>] and select necessary value from the list;
- Use **Hyperbola** function.

Hyperbola Function

Hyperbola function is available for profiles acquired with measuring wheel.

To determine wave speed by Hyperbola technique do the following. Find hyperbola (response from the small object) on the profile. Push **Hyperbola** button in the **Wave Speed** frame. Red colored hyperbola appears on the profile. Move your mouse cursor to the top of the hyperbola (response from the object). Align hyperbola with red colored one varying the wave speed. Wave speed in the media is determined.

incorrect   incorrect   correct
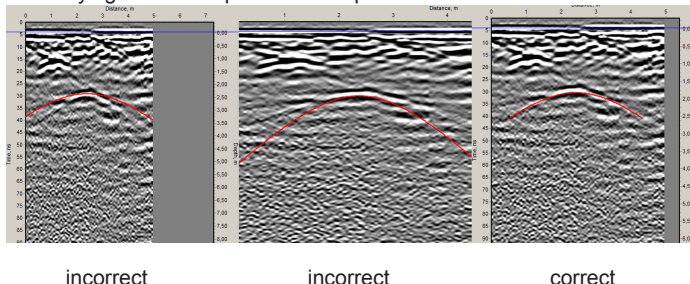
✓ The wave speed can be changed using the keyboard. Click on a profile, on the profile apear the red line. Using up/down key buttons for change of speed by ones. If by holding down the Shift key then up/down key buttons increases/reducing by ten units.

Comments Editing

Features of the data acquisition (place of work, conditions, special notes, etc.) are written in the **Comments** field. Comments help in deciphering the profile. Comments in the field are usually written in abbreviated form. Later, in a comfortable environment, they may be edited.

To edit comments tab in the **Profile Properties** of the Profile window and make any necessary changes in **Comments** field.

Change Movement Direction During the Data Acquisition

A lot of parallel profiles are easier to perform with Zig-zag style (see page 21). With this method of sounding odd profiles are acquired with **Forward** option, and even profiles with **Backward** option. Изменить направление движения можно в окне настройки георадара перед началом зондированиея. Для переворота профиля вокруг вертикальной оси необходимо нажать кнопку ⟨ Отразить горизонтально ⟩ в закладке Вид окна профиля.
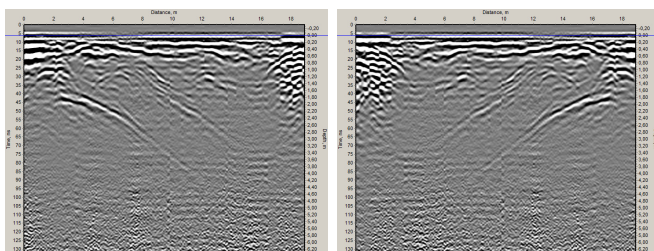
Display the Cursor Position

During the GPR profile analysis there is a need to determine coordinates of objects. To do this, move cursor to the object. In the **X / Y** section of the toolbar displays the cursor coordinates: **X** - distance on the surface of the starting point, **Y** - the depth of the object. The distance **X** is represented in the numbers of traces, as well as in meters (when using a topographic location, for example, measuring wheel.) The depth **Y** is represented in time (ns) from the beginning of the Survey window, and in meters from the zero level (taking into account wave speed in the medium). If the zero level offset is absent, the depth value in time and distance are the same.
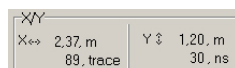
Zooming

Scale of the just opened profile is 100%, that is one pixel of the screen corresponds to a waveform sample. To zoom do one of the following:
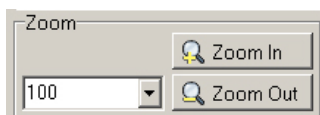
- Select **Profile > Zoom In** or **Profile > Zoom Out** in the Main menu program;
- Click **Zoom In** or **Zoom Out** button in the **Zoom** frame of the **View** tab of the Profile window;
- Select required scale from the drop-down list of **Zoom** frame of the **View** tab of the Profile window, or enter scale to the field and press **Enter**;
- Press «+» or «-» button of grey keyboard area;
- Point cursor on the profile, left-click and zoom by mouse wheel.

Set Up Proportions

Aspect ratio of the profile in the horizontal and vertical dimensions may vary within wide limits. One screen element (pixel) displays a sample of the vertical and one trace of the horizontal. Therefore, if the trace consists of 300 samples, and the profile is made up of 300 traces, the profile will be displayed in a square. When you scale, vertical and horizontal proportions are kept. However, there are cases when such mapping is not convenient. For example, if your profile contains 100 traces. In this case it is useful disproportionate change of scale.
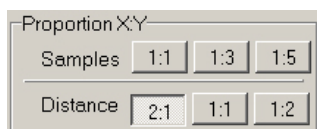
To wider the profile, select appropriate **Samples** option in the **Proportion X/Y** section of the **View** tab of the Operation window.

On the other hand, the X and Y are, in general, different value of division. For example, value of division on the X axis is in the centimeter or meter range, and the Y axis - in the millimeter and centimeter range. Binding to a commensurate value of division is useful in the profile analysis and interpretation of irregularities.

To display the profile in proportion to the dimension of the value of division, select the appropriate **Distance** option in the **Proportion X/Y** section of the **View** tab of the Profile window.

Grid Display

To switch on/off vertical grid, press **V Grid** button of the **View** tab of the Profile window.

To switch on/off horizontal grid, press **H Grid** button of the **View** tab of the Profile window.

Set Zero Level

Survey window is set so as to be visible direct pulse, passing over the surface of the earth. To correctly measure the depth is necessary to combine top of the depth scale to a certain point on the pulse (maximum amplitude, transition through zero, etc.).

Synchro3 program provides to set zero level manually or automatically. To set zero level, click **Set Zero Level** button of the **View** tab of the Profile window. A dialog box appears:
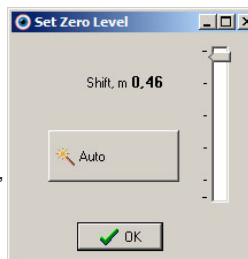
Press **Auto** button to set zero level in the automatic mode. If the result is unsatisfactory, go to manual mode. To do this, one of the following:

- Place cursor on the scroll bar and drag it to the desired location while holding down the left mouse button;
- Left-click on the scroll bar. To set zero level, use mouse wheel;
- Set zero level by Up/Down buttons of your keyboard.

Zero level is displayed on the profile by a horizontal line of blue.

Markers Display and Editting

Markers are used for display on the profile special elements of the measuring range (corners of buildings, doorways, pillars, hatches, subsidence, etc.). Markers are set at the time of the data acquisition when you press Space button.

To display markers on the profile, click **Show** button of the **View** tab of the Profile window. Click the button again to cancel the markers display.

To edit marker, click **Edit** button of the **View** tab of the Profile window.

Display Single Trace

Display of single trace on the profile is useful for its ana

To display single trace, do the following:

- Click **Wiggle** button of the **View** tab of the Profile window;
- Move the cursor to the desired area of the profile;
- Click the left mouse button. Single trace (A-scan) will appear on the profile as green wiggle.
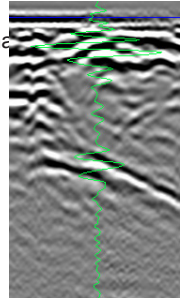
Topographic Correction

Realistic sites for GPR sounding are rarely flat and horizontal. Displaying GPR profile as a rectangle distorts, if the site surface had elevations and antenna unit not move horizontally.

Some antenna unit equipped with built-in inclinometers that allows to consider antenna unit orientation during the data acquisition. There are AB3-700i, AB3-300i and AB3-125i (VIY3-700i, VIY3-300i and VIY3-125i packages).

The **Topographic correction** button is available if data acquisition was made with measuring wheel. When you press the button, the program calculates zero-level of the profile taking into account surface curvature based on antenna tilt and traveled distance. Then considering tilt of the antenna unit and antenna directional pattern a new profile is calculated.
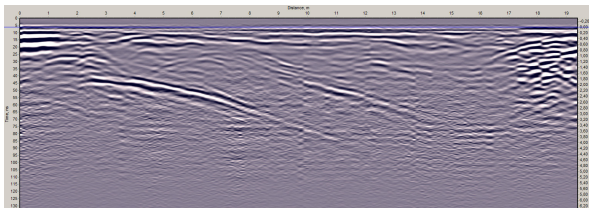
Initial profile sounding surface of a slope
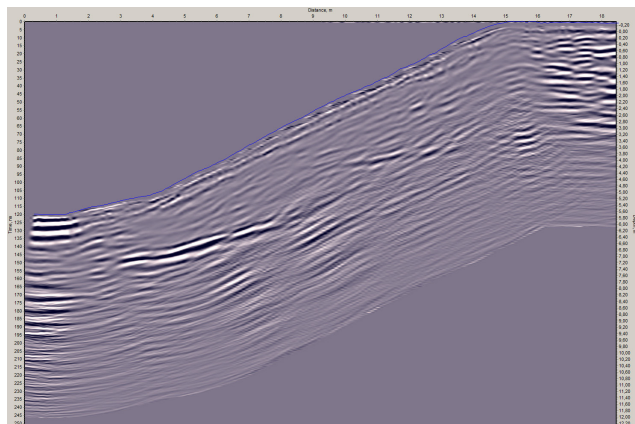
Result of topographic correction of the profile

✓ Check the inclinometers calibration before the data acquisition, see page 28 for detail

Profile Display

Using Palette

Trace amplitude of the GPR profile is coded by color. Visual presentation is presented in the **Palettes** tab. Above the sample of the GPR trace (green) current palette is shown. The trace amplitude corresponds to the palette's color. Result of the trace encoding by the current palette is shown to the right.

To edit the current palette is design working bar with sliders (at least two). Palette results in a smooth transition between colors of sliders. Grayscale palette is used by default - from black to white.
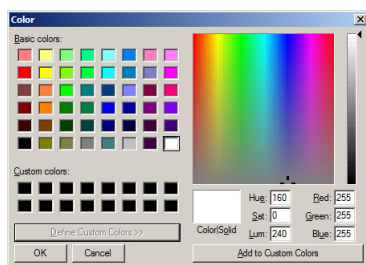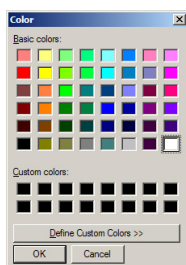
Double-click to the slider to change it color. Dialog box for color selecting is appeared.

Click to **Define Custom Colors** button to display advanced dialog box. Select the desired color and click OK. Color of the selected slider will change. Current palette and profile display will be changed also.

Double-click to the working bar to add a new slider. Modify color of the new slider. Move the slider along the workiing bar by left mouse button.

To remove the slider select it by left mouse button and press Delete.

✓ The ends left and right sliders can not be moved or deleted.

Current palette is saved in the file of current GPR profile. Click **Save Palette** button to store the palette in the Palettes library. A new button with image of this palette is shown in Palettes library.

Press and hold Ctrl to remove palette from Palettes library. In this case near the cursor appears icon ✖. Click on the palette button. The palette will be removed from the Palettes library. Palette removal from the Palettes library does not change GPR profile to which it was applied.

Click on the appropriate button in the Palettes library to apply this palette for the current GPR profile.

Export

Synchro3 program exports profile (with applied tools) to the following formats: text, bitmap and SEG-Y.

To export profile to bitmap format, do the following:

- Select **File > Export > to bitmap**;
- Enter file name to File name field of Save as Text File dialog box;
- Press Save.

Name of bitmap file is matched with name of exported profile by default. But extension is changed from *.sgpr to *.bmp.

To export profile to text format, do the following:

- Select **File > Export > to text**;
- Enter file name to File name field of Save as Text File dialog box;
- Press **Save**.

Name of text file is matched with name of exported profile by default. But extension is changed from *.sgpr to *.dat.

The data in the text file are presented with three columns separated by spaces:

xx yy ffff
xx yy ffff
xx yy ffff
where

xx –X coordinate
yy – Y coordinate
ffff – sample amplitude
GPS data are exported to separate file. The file name is the same and extension is *.gps.

Example of *.gps file.

Source File=C:\Transient Technologies\VIY3\data\ges2.sgpr

################

Trace No=   NMEI
0                 $GPGGA,144339.000,0223.6416,N,07539.6695,W,1,07,...
12                $GPGGA,144708.000,0223.5717,N,07539.7319,W,1,00,...
23                $GPGGA,144905.000,0223.5122,N,07539.7545,W,1,00,...
67                $GPGGA,145341.000,0223.4824,N,07539.7490,W,1,07,...
To export profile to SEG-Y format, do the following:

- Select **File > Export > to SEG-Y**;
- Enter file name to File name field of Save as SEG-Y File dialog box;
- Press **Save**.

Name of text file is matched with name of exported profile by default. But extension is changed from *.sgpr to *.seg.

GPS data are exported to separate file. The file name is the same and extension is *.gps.

Example of *.gps file.

Source File=C:\Transient Technologies\VIY3\data\ges2.sgpr
################
Trace No=   NMEI
0                 $GPGGA,144339.000,0223.6416,N,07539.6695,W,1,07,...
12                $GPGGA,144708.000,0223.5717,N,07539.7319,W,1,00,...
23                $GPGGA,144905.000,0223.5122,N,07539.7545,W,1,00,...
67                $GPGGA,145341.000,0223.4824,N,07539.7490,W,1,07,...

Print

Synchro3 program uses Windows operating system capabilities to print processed profile (with applied tools).

To print the profile, do the following:

- Select **File > Print**;
- Select printer and adjust the print settings in the Print dialog box;
- Press **OK**.

Profile is placed on A4 paper. At the top of the sheet is a header, which contains reference information about the profile (in according with **Profile Properties** tab).
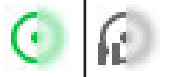
Profile Processing
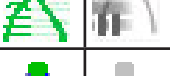
Profile Processing Algorithm

Synchro3 program can process profiles acquired by VIY2 and VIY3 series GPR.

Profile processing by Synchro3 software is organized the following manner. Computer memory stores two files with the same name but different extensions. There are original data file (*.sgpr) and tools file (*.tls). Tools file contains a list of applied tools, their adjustments and sequence of their application. Such a way if preprocessed file is opened first, tools in accordance with the list process the raw data, and then the result is displayed on the screen.

List of applied tools appears in the **Tools** tab in the form as a tree. Tools are managed by using the buttons from **Tools** tab or by mouse.

Synchro3 program provides the following tools:

Icons		Tool Name
		Rectifier
		Blur
		Comparator
		Nonlinear Amplifier
		Three-Point Correlator
		LPF/HPF
		Band Pass Filter
		Hilbert Transform
		Gain
		Wavelet Filter
		Windowed Background Removal
		Migration

Appearance of active tool icon changes during the processing. Green triangle is in the lower left corner of the icon. Icon will fade if the tool is not active.

Add Tool

To add the tool, click **Add** button of the **Tools** tab of the Profile window.

Select desired tool in **List of Tools** window and click **Apply Tool**. Selected tool appears in tools window of **Tools** tab. The profile in the Profile window changes in according with tool options set by default.

In Converters tab placed tools that transform profile. The speed of the
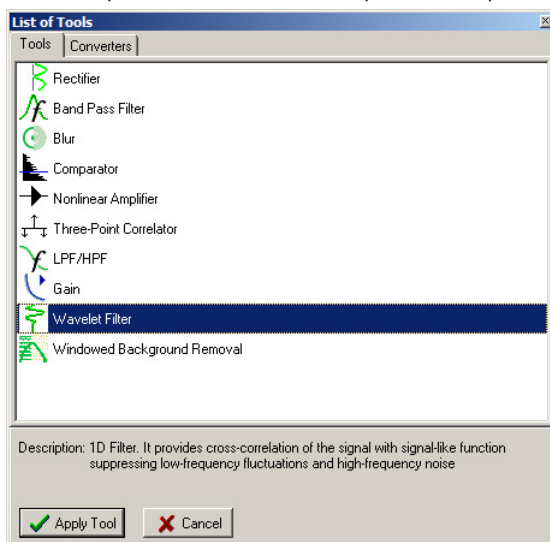
converter is lower than other filters.
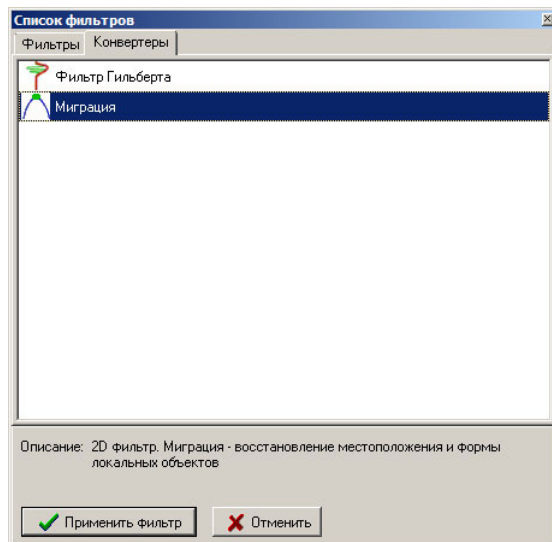
Edit Tool Settings

To edit the tool settings, do one of the following:

- Select desired tool from tools tree and click **Properties** button of the **Tools** tab of the Profile window;
- Right-click on the desired tool and select **Properties** from the context menu.

Dialog box for tool settings will appear. For details, see description of appropriate tool in the References section.

Change the Order of Tools

Tools in the Tools area are arranged in a list (tools tree). Tools apply to profile sequentially from top to bottom.

To change order of tools, do the following:

- Move cursor over the tool name and left-click;
- While holding the button, move the cursor around the tools tree. Appears grey horizontal line, which shows the filter location in future;
- Move the line to desired location and release the mouse button.

As soon as you change the order of tools, profile will be processed in a new sequence and results will be displayed in real time.

Remove Tool

To delete tool from the tools tree, do one of the following:

- Select desired tool from tools tree and click **Remove** button of the **Tools** tab of the Profile window;
- Right-click on the desired tool and select **Remove** from the context menu;
- Select desired tool from tools tree and push **Delete** button on the keyboard.

As soon as you remove the tool, profile will be processed in a new sequence and results will be displayed in real time.

Remove All Tools

To delete tools tree, click **Clear Set** button of the **Tools** tab of the Profile window.

Once you remove the tool tree, original profile will be displayed.

   ✓ In this case tools or tools trees matched with other profiles
      are not removed

Save Set of Tools

Adding and editing of the tools to process the profile takes some time. To reduce the preparation time to process profiles, set of tools can be saved.

To save a set of tools, select and adjust tools, create tools tree, and do one of the following:

- Click **Save Set** button of the **Tools** tab of the Profile window.
- Right-click on the tools tree and select **Save this Set to Stencil List** from the context menu;

Enter name of the stencil in the **Save Set of Tools** dialog box and click **Save** button. The name of stored set of tools will appear in the drop-down list of **Tools** tab of the Profile window.

Apply Set of Tools

To apply set of tools for profile processing, select stencil from drop-down list of **Tools** tab of Profile window. In this case current tools tree will be replaced with tools of the set.

The profile will be processed again in accordance with the new set of tools. Results of the profile processing will be displayed in real time.

Tools

Tool configuration windows are quite different when the tool is added or edited. They differ in purpose of some buttons. The Synchro3 software provides the following tools.

Rectifier
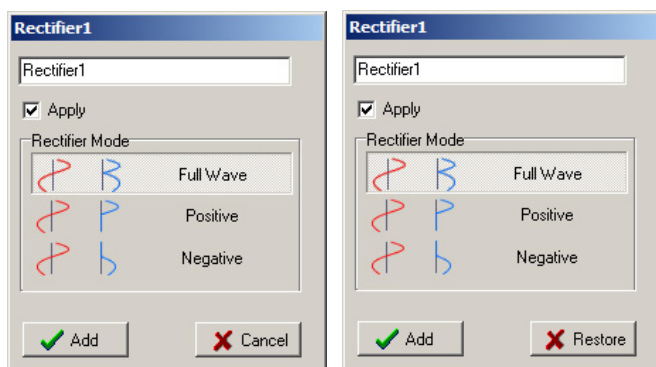
The **Rectifier** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Rectifier Mode	Select the type of rectifier: full-wave and half-wave (positive or negative).
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The tool rectifiers traces of the profile.

The **Full-wave rectifier** inverts negative half-wave and remains positive halfe-wave unchanged. The tool is intended to detect specific features in the profile (synphasal line, for example). It is used during the GPR data interpretation.

The **Half-wave rectifier** resets to zero positive (negative) half-wave, and the rest remains the same (positive) or inverts (negative). Half-wave rectifier is designed to determine reflection properties (polarity, for example). Applied to the GPR data interpretation. Will be useful for localization of geological strata, ground water table, suffosion areas etc.
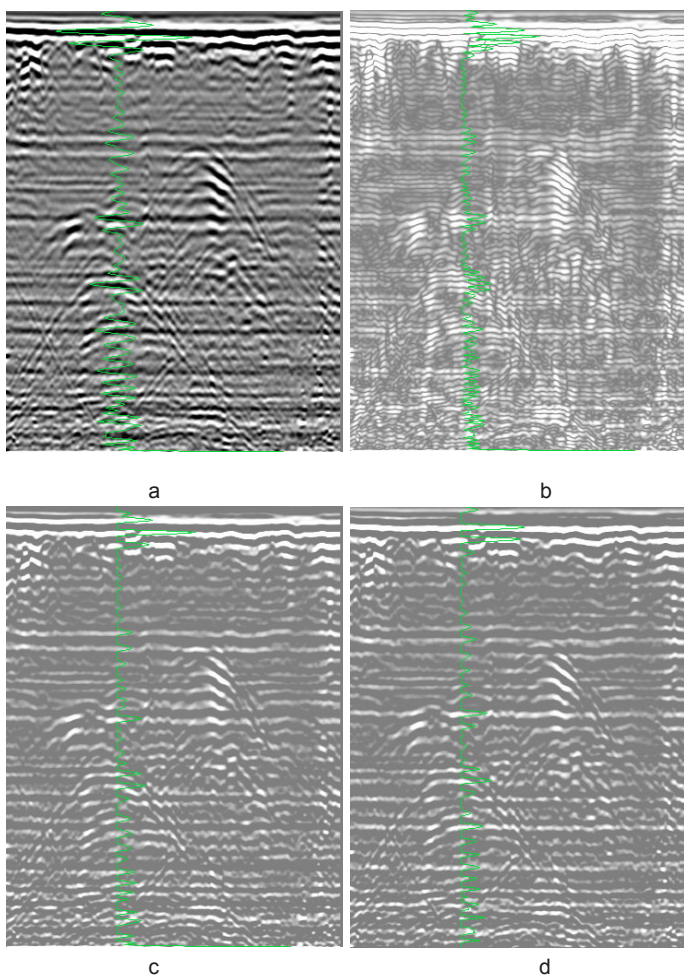
The **Rectifier** application results: a – initial profile, b – profile processed by full-wave rectifier, c - profile processed by positive half-wave rectifier, d - profile processed by negative half-wave rectifier.

Blur
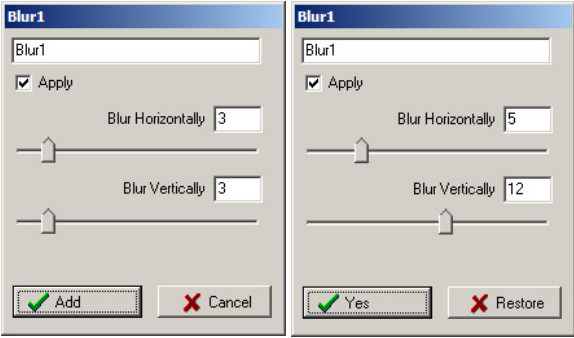
The **Blur** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Blur Horizontally	Control smoothing of the GPR profile across. Fits slider or in the field.
Blur Vertically	Control smoothing of the GPR profile along the vertical. Fits slider or in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Blur** smoothes out sharp edges of the profile. It reduces interference that appears as "ripples" or "sand." Horizontal blur improves display of geological layers in the profile, resulting in heavy conditions of data acquisition (GPR moving on rugged terrain).

Changing the setting can be done using the sliders or by specifying a numerical value in the boxes. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 10.

a   b
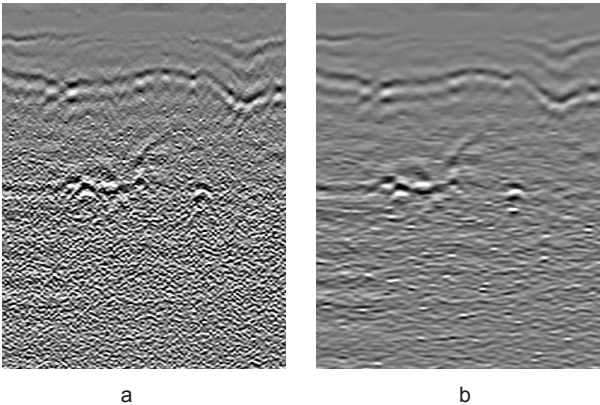
The **Blur** application result: a – initial profile, b – processed profile.

Comparator
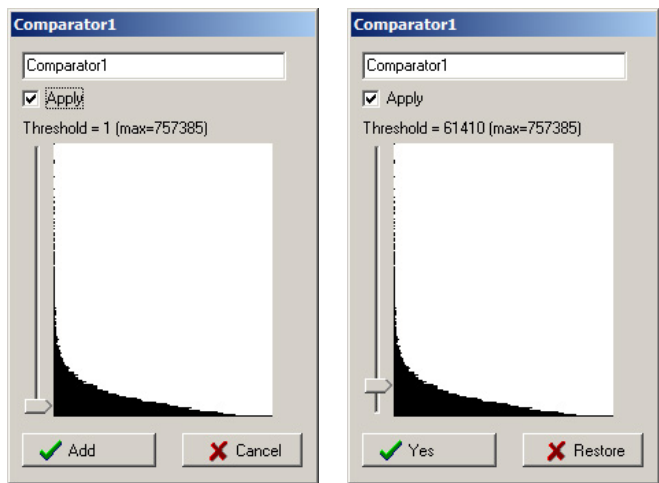
The **Comparator** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Threshold	Threshold adjustment. Fits slider.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Comparator** resets to zero trace samples the absolute value are below than specified threshold. It removes weak signals and noise leaving on the profile contrast signals only.

a   b

The **Comparator** application result: a – initial profile, b – processed profile.

Nonlinear Amplifier
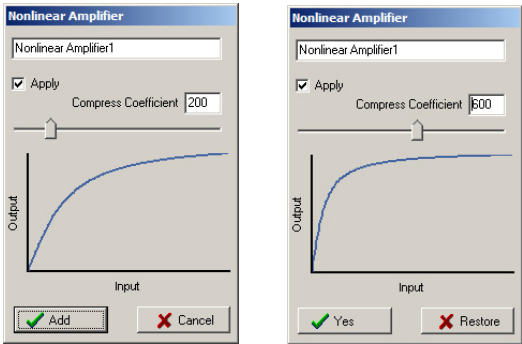
The **Nonlinear Amplifier** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Compress Coefficient	Adjusts the amount of dynamic range compression of the signal. Improves the profile contrast. Fits slider or in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Nonlinear Amplifier** increases weak and suppresses strong signals compressing dynamic range of the profile. The tool makes visible weak signals while maintaining contrast of the profile.

Changing the setting can be done using the slider or by specifying a numerical value in the box. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 10.

a   b

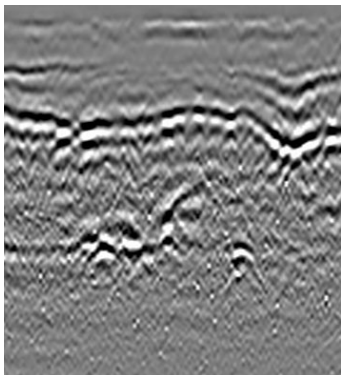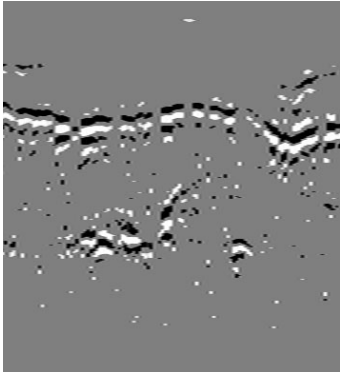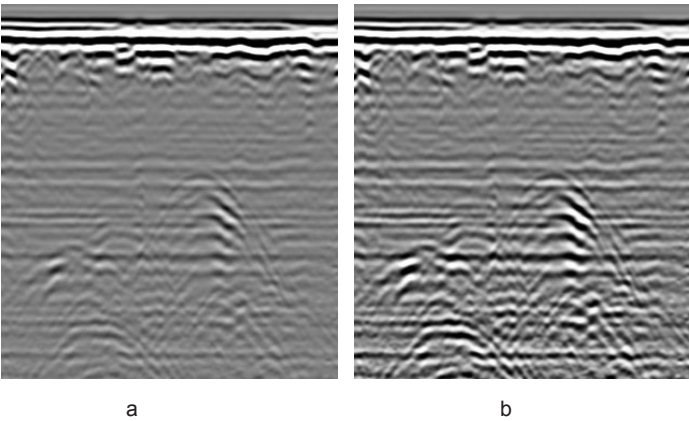The **Nonlinear Amplifier** application result: a – initial profile, b – processed profile.

Three-Point Correlator
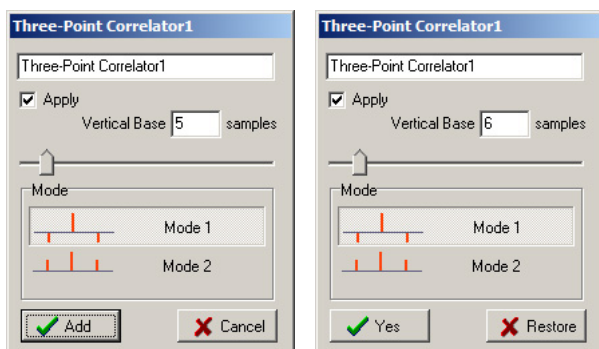
The **Three-Point Correlator** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Vertical Base	Adjust the distance between elements of a discrete function. Fits slider or in the field.
Mode	Operating mode selection.
Mode 1	Discrete function (Haar wavelet derivative).
Mode 2	Samples averaging.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Three-Point Correlator** is a versalite tool.

In **Mode 1** it produces the second derivative of the trace (**Vertical Base** value is equal 1). It allocates reflections from underground facilities by non-linear filtering.

In **Mode 1** the tool performs cross-correlation the trace with discrete function (Haar wavelet derivative) (**Vertical Base** value is greater than 1). It sharpens boundaries and increases special resolution of the profile when value of **Vertical Base** is small. Selection of optimal **Vertical Base** parameter improves contrast of the profile.

In **Mode 2** it provides mooving average - blur with triangular window (**Vertical Base** value is equal 1). It can be used to smooth traces in the profile.

In **Mode 2** the tool averages sparse samples of the trace (**Vertical Base** value is greater than 1). It suppresses periodic oscillations of arbitrary shape. The tool may be useful to reduce visibility "ringing" on the profile, which are badly processed by other tools.

Changing the setting can be done using the slider or by specifying a numerical value in the box. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 10.
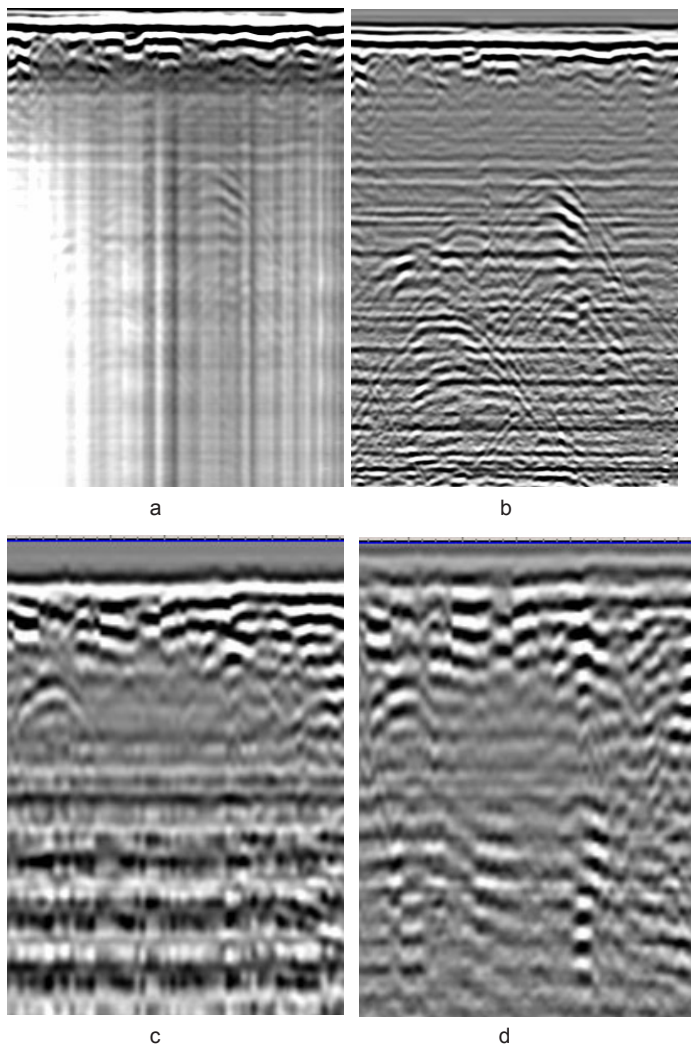
The **Three-Point Correlator** application results: a, c – initial profile, b – processed profile (**Mode 1**), d - processed profile (**Mode 2**).

Low Pass Filter / High Pass Filter
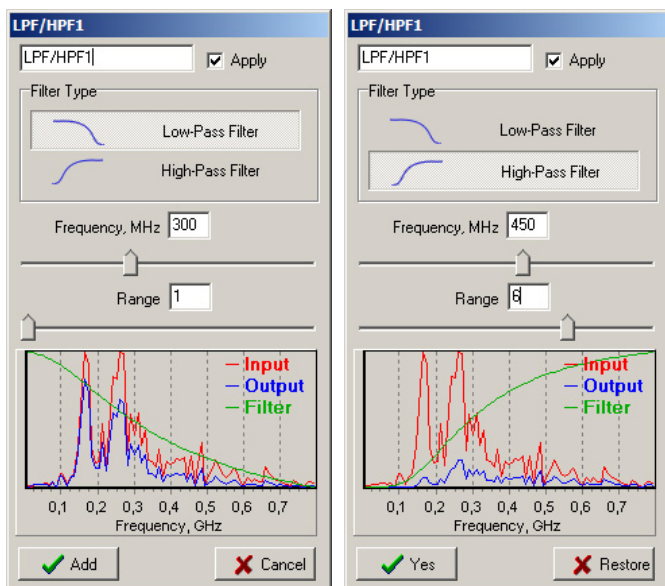
The **LPF/HPF** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Filter Type	Select type of the filter: low-pass filter (**LPF**) or high-pass filter (**HPF**).
Frequency	Adjust cutoff frequency of the filter. Fits slider or in the field.
Range	Adjust slope (attenuation) of the filter. The slope increases with the range change from 1 to 8. Fits slider or in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Low-Pass Filter** (**LPF**) passes frequencies below the cutoff frequency (**Frequency** value) and suppresses frequencies above it. The suppression in determined by **Range** value.

The **High-Pass Filter** (**HPF**) passes frequencies above the cutoff frequency (**Frequency** value) and suppresses frequencies below it. The suppression in determined by **Range** value.

Spectra of the initial and processed traces as well as normalized frequency response are presented on the filter configuration window. Results of the filter operation are displayed in real time.

Consistent application of the **LPF** and **HPF** allows for bandpass or bandstop filter.

The **LPF/HPF** is used to adjust the spectral composition of the profile (for example, suppressing low-frequency fluctuations, high-frequency noise, certain types of reverb, etc.).

Changing the setting can be done using the sliders or by specifying a numerical value in the boxes. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 10.
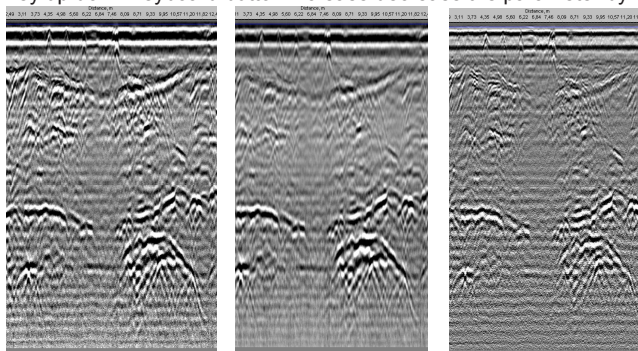
The **LPF/HPF** application results: a – initial profile, b – **LPF** processed profile, c – **HPF** processed profile.

Band Pass Filter / Band Stop Filter
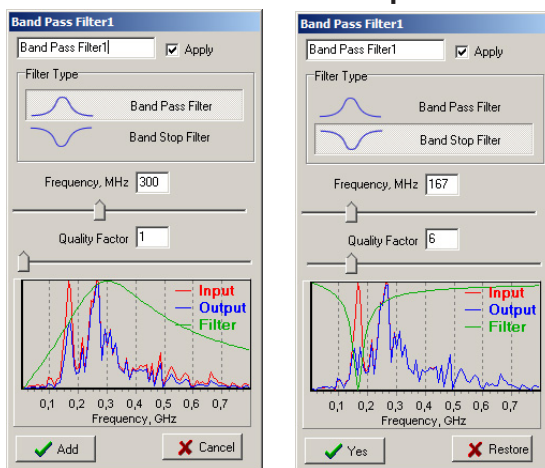
The **BPF/BSF** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Filter Type	Select type of the filter: bandpass (**BPF**) or bandstop (**BSF**).
Frequency	Adjust central frequency of the filter. Fits slider or in the field.
Quality Factor	Adjust quality factor (**Q**) frequency of the filter. Fits slider or in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Band Pass Filter** (**BPF**) passes spectral components of the trace in a given band and suppresses components beyond.

The **Band Stop Filter** (**BSF**) suppresses spectral components of the trace in a given band and passes components beyond.

Bandwidth (or suppression) is determined by **Frequency** and **Quality Factor** (**O**) parameters. The greater the **Q** value the narrower bandwidth (or suppression).

Spectra of the initial and processed traces as well as normalized frequency response are presented on the filter configuration window. Results of the filter operation are displayed in real time.

The **BPF/BSF** is used to adjust the spectral composition of the profile (for example, to suppress certain types of reverb, etc.).

Changing the setting can be done using the sliders or by specifying a numerical value in the boxes. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 10.

a   b   c
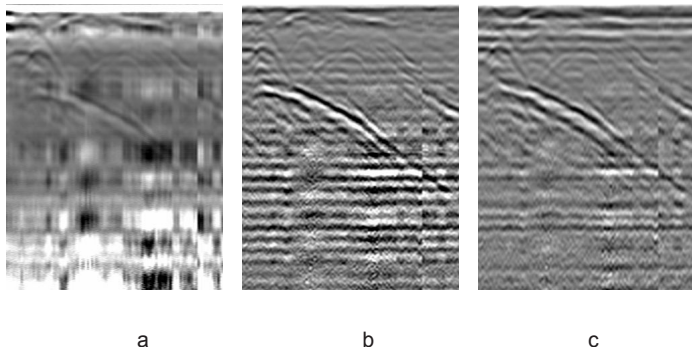
The **BPF/BSF** application results: a – initial profile, b – **BPF** processed profile, c – **BSF** processed profile.

Gain
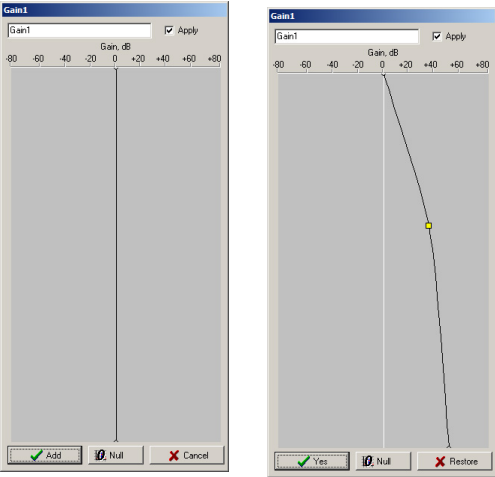
The **Gain** configuration window contains the following items:

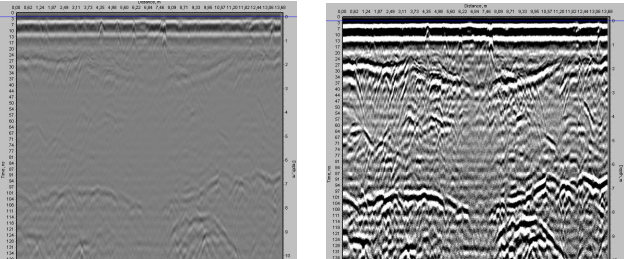|	
Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Null	Returns the gain curve to zero position with removal of intermediate nodes.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The tool graphically sets the gain of the trace in depth in the range from -80dB to +80dB. Initial gain curve has two node points, moved to the top and bottom of the window, respectively. Movement of node points set a linear change in gain in depth. Move the cursor to node point (its appearance change). Press the left mouse button and drag the node point.Adding intermediate nodes does change of the curve shape. To add a new node point, hold down the Ctrl button, move cursor to the gain curve and right-click. In place of the cursor position a new node point will appear. To delete node point, hold down the Ctrl button, move cursor to the desired node point and right-click. The node point will disappear. Alignment of the signal amplitudes results to optimal contrast of profile view.
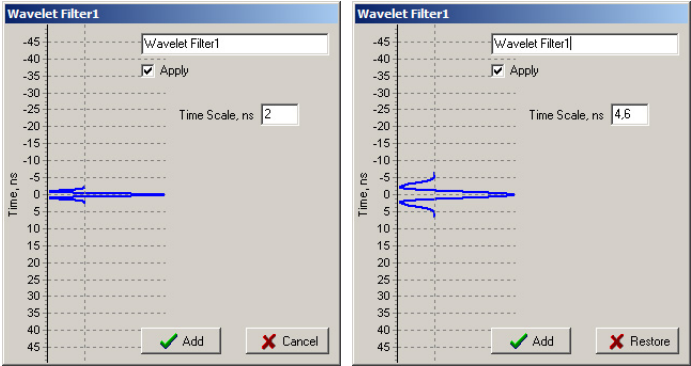

a   b

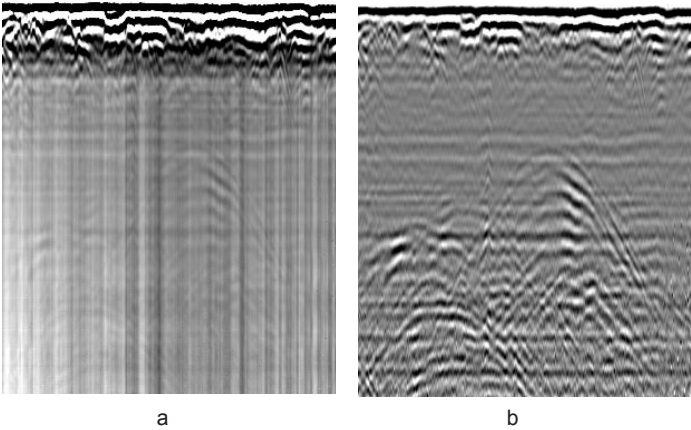The **Gain** application result: a – initial profile, b – processed profile.

Wavelet Filter

The **Wavelet Filter** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Time Scale	Adjust the wavelet function. Fit in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Wavelet Filter** performs cross-correlation the trace with a special function - MHAT wavelet. The tool effectively suppresses low-frequency fluctuations and high-frequency noise.

Changing the setting can be done by specifying a numerical value in the boxes. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 0.1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 1.

a	b

The **Wavelet Filter** application result: a – initial profile, b – processed profile.

Windowed Background Removal
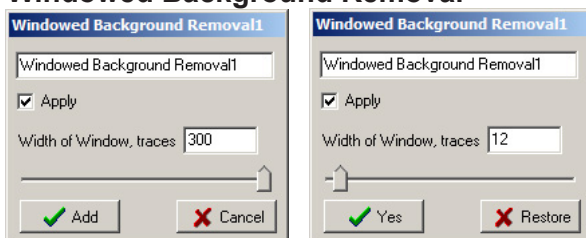
The **Windowed Background Removal** configuration window contains the following items:

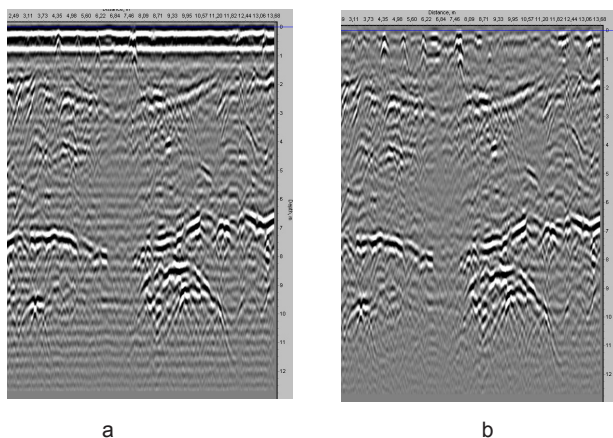|	
Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Width of Window	Adjust width of the window for calculation of average trace. Fits slider or in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The **Windowed Background Removal** subtracts averaged trace from each trace of the profile. Width of the window for averaging is specified by traces value (from 1 to the total).

The tool removes from the profile horizontal lines. The tool sensitivity is determined by Width of Window parameter. The smaller the value, the shorter horizontal fragments are removed from the profile.

a   b

The **Windowed Background Removal** application result: a – initial profile, b – processed profile.

Hilbert Filter
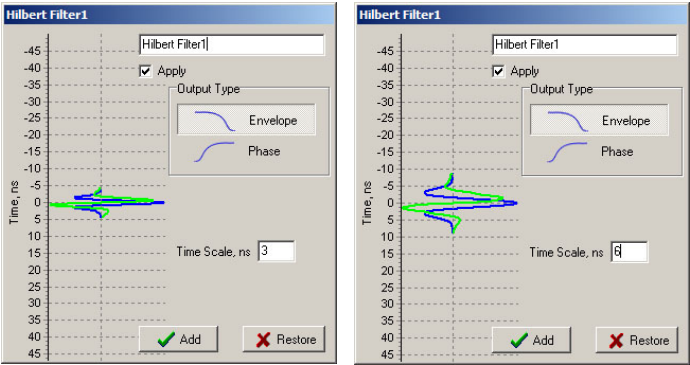
The **Hilbert Filter** configuration window contains the following items:

Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Output Type	Envilope or the phase of a signal
Time Scale	Adjust the wavelet function. Fit in the field.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The tool using the Hilbert transform allocates envelope of the trace that contains information about its energy. The **Hilbert Filter** allows selecting on the profile areas of high humidity with no clear reflectors, suffusion zones, etc.

Changing the setting can be done by specifying a numerical value in the boxes. Input box accepts only numbers, as well as pressing the up/down keyboard buttons. Use up keyboard button to increase the parameter to 0,1, down - to decrease. If holding down the Shift key up/down keyboard button increase/decrease the parameter by 1.

a   b
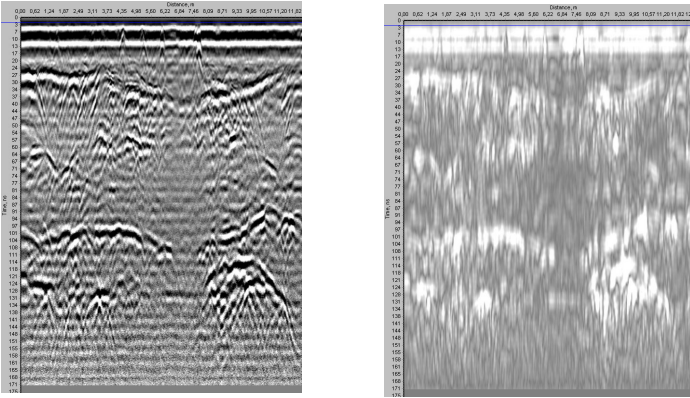
The **Hilbert Filter** application result: a – initial profile, b – processed profile.

Migration
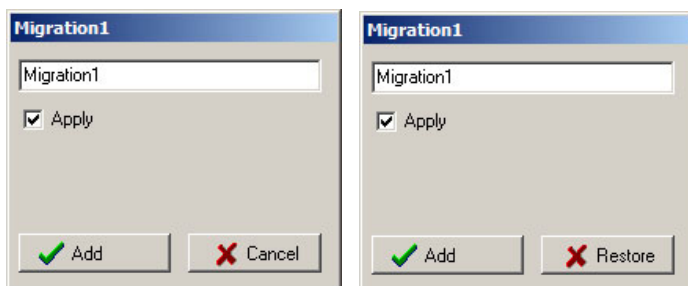
The **Migration** configuration window contains the following items:

| Edit Box	This field specifies tool name. Initially the field contains tool name by default. The tool name can be edited.
Apply	The tool is activated when is checked.
Add	Add tool.
Cancel	Stop adding tool.
Yes	Apply tool after options editing.
Restore	Restore the last saved tool configuration.

The Migration is tool for restoration of the location and shape of local objects.

The Migration tool works correctly when properly configured speed of the wave. See "Hyperbola Function" on page 36.

a   b
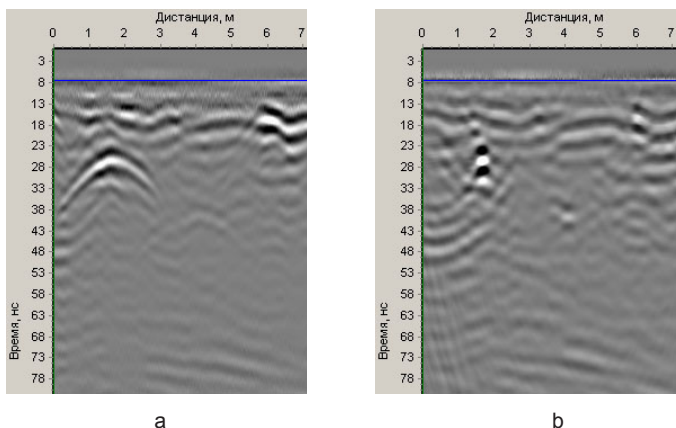
The **Migration** application result: a – initial profile, b – processed profile.

Specifications

Model of GPR	VIY3-070	VIY3-125	VIY3-300	VIY3-500	VIY3-700
Antenna frequency, MHz:	70	125	300	500	700
ADC, bits:	18				
Dynamic range, dB:	at least 135 дБ				
Data acquisition rate:	up to 146 traces per second*				
Survey window, ns:	240, 360, 480,600	120, 180, 240, 300	66, 100, 133, 166	32, 50, 64, 80	16, 24, 32, 40
Samples per trace:	up to 1000				
Trace Stacking:	up to 128				
Maximum depth of sounding (depended by medium properties), m:	35	15	8	4	2,5
Spatial resolution, m:	1,5	1,0	0,3	0,18	0,12
Trigger mode:	Single, Internal, External				
File size of single profile:	up to 1 000 000 traces				
Interface:	USB2 (WiFi optional)				
Continuous operation time, hours:	4 and more	8 and more			
Dimensions, mm:	1207x607x308 1207x607x308	1105x580x232	610x312x170	311x176x152	311x176x152
Weight, kg:	2 * 40	25	8,4	3,0	3,0
Operating temperature:	from -20°C to 40°C				

* - Data acquisition rate depends on samples per trace and trace stacking.

Order information

VIY3-500iw

Series title — Central frequency MHz — Built-in inclinometers — built-in WiFi channel

	VO-20	Cart-36	Cart-6
Step, mm:	31	26,54	159,24
Cable length, m:	0,9	0,4	0,4
Operating dimensions, mm	240x140x200	1000x500x970	1580x500x320
Transport dimensions, mm	240x140x200	845x500x320	845x500x320

Weight, kg:	0,7	12,8	8,5
Operating temperature:	from -20°C to 40°C		

✓ Design and specification are subject to change without prior notice.

WiFi Specification

Build-in 2.4-GHz IEEE 802.11b/g transceiver

EMC Compliance Information

Specification	Compliance
FCC	ID U3O-G2M5477 Part 15.247
IC (Canada)	RSS-210
CE	EU ID # 0681
REG	U9M20901-1000-C
RADIO	EN 300328 V1.7.1 (10/2006)
EMC	EN 301489-1 V1.8.1 (04/2008), EN 301489-17 V1.3.2 (04/2008)
SAFETY	EN 60950-1:2001+A11:2004

Limited Warranty

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